MACHINERY

KNURLS AND KNURLING OPERATIONS—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

DOUGLAS T. HAMILTON*

Douglas T. Hamilton†

IN designing a set of cams for knurling operations on the Brown & Sharpe automatic screw machines, it is desirable that as little experimental work as possible be required. The following formulas and data have been derived and collected by the writer for use in work of this kind, and are here presented with the hope that they will prove of value to others. Before taking up the data and formulas, the different tools and appliances necessary for knurling will be briefly reviewed.

Rear Cross-slide Knurl-holder

A very solid and rigid rear cross-slide knurl-holder is shown in Fig. 1. It is held by means of the cap screw B on the outside face A of the cross-slide tool-holder. This screw also holds the circular cut-off tool in position. The holder allows the knurl to pass over the work, and returns it after the piece has been cut off. The holder is simple and cheap, and covers a wide range of work, as the distance C to the circular cut-off tool can be changed so that the work will be cut off closer or further away from the knurl, as desired. The set-screw D supports the knurl-holder rigidly, and also provides means for adjusting. The oil hole E permits a good supply of oil to reach the knurl for removing all
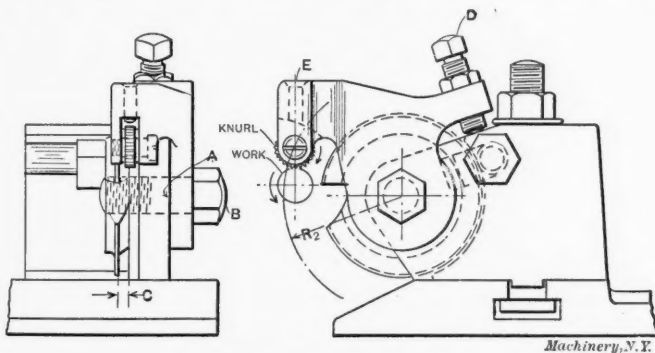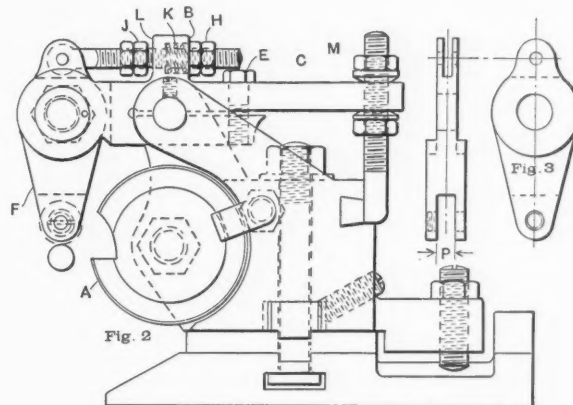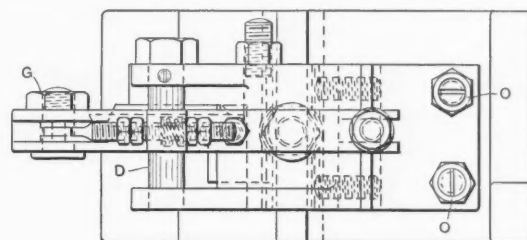

Fig. 1. Rear Cross-slide Knurl-holder

chips. This holder, however, can be used only on the tool-holder which carries the cut-off tool, because the finished piece must be severed from the bar before the knurl can return.

Universal Cross-slide Knurl-holder

The knurl-holder shown in Fig. 1 is limited in its range, but the one shown in Fig. 2, while more expensive and complicated, is also more efficient and universal. This holder eliminates the cross-slide tool-post, and carries the circular cut-off tool A in the same way as it would be held in the ordinary tool-post. It can also be used in conjunction with either circular form or cut-off tools on the front cross-slide. The knurl can operate at any desired position on the work by moving

the arm C along the bar D and then clamping it by means of the cap screw E. The holder F which carries the knurl can be moved in or out to any position to suit the different diameters of stock being knurled, and is adjusted by means of adjusting nuts H and J. The nut G is adjusted to insure a good working fit of the holder, and also prevents side movements. When the knurl passes over the stock the nut H is brought up against the face B of the arm C, and also puts a tension on spring K, so that when the knurl has passed over the work and the pressure on the spring is released, the spring forces the nut J up against the face L and permits

Figs. 2 and 3. Universal Cross-slide Knurl-holder

the knurl to clear the work when passing back over the stock. The nuts M permit the arm C to be raised or lowered for different diameters of stock. The washers are convex as shown so that the arm is held firmly even when at an angle to the face of the nuts M. Screws O tend to steady the holder.

In Fig. 3 the knurl-holder proper is shown in detail. It will be seen that knurls of different widths may be used by making the distance P to suit.

Straight Knurls

Straight knurls, as shown in Fig. 4, are generally cut in the milling machine with a cutter of the desired angle. The greatest difficulty is met with in selecting a suitable angle for the teeth for knurling different materials. A blunt knurl will work better on soft materials than one with a more acute angle. The writer has found by experiments that the following angles are satisfactory for the materials specified:

Materials	Angle
Brass and hard copper	90 degrees.
Gun screw iron	80 degrees.
Norway iron and machine steel	70 degrees.
Drill rod and tool steel	60 degrees.

When laying out a set of cams for knurling operations, it is necessary to know the depth of the tooth in the knurl.

If d = depth of tooth in knurl,

p = circular pitch of knurl,

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$P =$ "pitch of knurl" $=$ number of teeth in one inch of the

$$\text{circumference} = \frac{1}{p},$$

$a =$ included tooth angle of knurl,

then, for all practical purposes, the depth may be calculated as follows: When
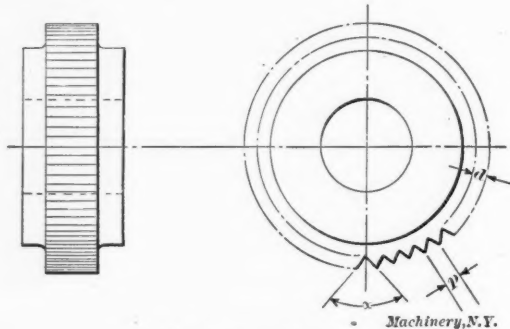
$$a = 90 \text{ degrees, } d = \frac{p}{2},$$

Fig. 4. Straight Knurl

$$a = 80 \text{ degrees, } d = \frac{p}{2} \times \tan 50 \text{ degrees,}$$

$$a = 70 \text{ degrees, } d = \frac{p}{2} \times \tan 55 \text{ degrees,}$$

$$a = 60 \text{ degrees, } d = \frac{p}{2} \times \tan 60 \text{ degrees.}$$

The values of d for different pitches ranging from 16 to 62 teeth per inch of circumference have been calculated from these formulas and are given in Table I.

Concave Knurls

The designing of a concave knurl which will work satisfactorily is, in most cases, a difficult problem, as the radius of the knurl cannot have the same radius as the piece to be

TABLE I. DEPTH OF TEETH IN KNURLS

P = number of teeth in one inch of circumference
p = circular pitch
a = included angle of tooth
d = depth of tooth

P	p	$a = 90°$	$a = 80°$	$a = 70°$	$a = 60°$
		d	d	d	d
16	0.0625	0.0312	0.0371	0.0445	0.0540
18	0.0555	0.0277	0.0330	0.0395	0.0480
20	0.0500	0.0250	0.0297	0.0357	0.0433
22	0.0454	0.0227	0.0260	0.0324	0.0393
24	0.0416	0.0208	0.0247	0.0297	0.0360
26	0.0384	0.0192	0.0228	0.0274	0.0332
28	0.0357	0.0178	0.0212	0.0254	0.0308
30	0.0333	0.0166	0.0199	0.0237	0.0287
32	0.0312	0.0156	0.0185	0.0222	0.0270
34	0.0294	0.0147	0.0175	0.0209	0.0254
36	0.0277	0.0138	0.0164	0.0197	0.0239
38	0.0263	0.0131	0.0156	0.0187	0.0226
40	0.0250	0.0125	0.0148	0.0178	0.0216
42	0.0238	0.0119	0.0142	0.0169	0.0206
44	0.0227	0.0113	0.0134	0.0161	0.0195
46	0.0217	0.0108	0.0128	0.0154	0.0187
48	0.0208	0.0104	0.0124	0.0148	0.0180
50	0.0200	0.0100	0.0119	0.0142	0.0173
52	0.0192	0.0096	0.0114	0.0137	0.0166
54	0.0185	0.0092	0.0109	0.0131	0.0159
56	0.0178	0.0089	0.0106	0.0127	0.0154
58	0.0172	0.0086	0.0102	0.0122	0.0148
60	0.0166	0.0083	0.0099	0.0118	0.0143
62	0.0161	0.0080	0.0096	0.0114	0.0138

knurled. It will be seen in Fig. 5 that if the knurl and the work are of the same radius, the material compressed by the knurl will be forced down on the shoulder A and will consequently make a poor looking job. The writer, having met with this difficulty, finally devised an empirical formula which gives satisfactory results.

A design of a concave knurl is shown in Fig. 6, and all the important dimensions are designated by letters. To find these dimensions, the pitch of the knurl required must be known,

and also approximately the throat diameter B. This diameter, of course, must suit the knurl holder used, and be such that the circumference contains an even number of teeth with the required pitch. When these dimensions have been decided upon all the other unknown factors can be found from the formulas given in the following.

Let $R =$ radius of piece to be knurled,

$r =$ radius of concave part of knurl,
$C =$ radius of cutter or hob used for cutting the teeth in the knurl,
$B =$ diameter over concave part of knurl (throat diameter),
$A =$ outside diameter of knurl,
$d =$ depth of tooth in knurl,
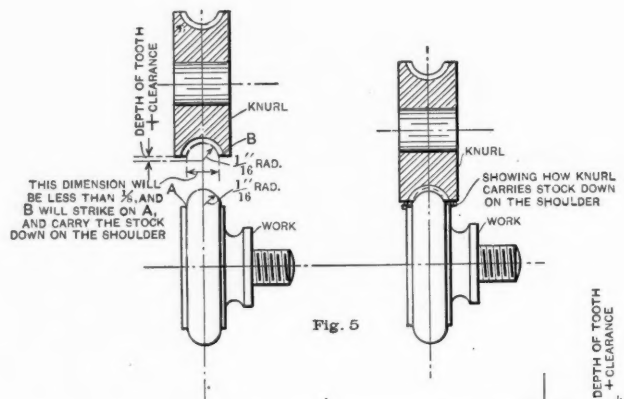$P =$ pitch of knurl (number of teeth per inch circumference),

Figs. 5 and 6. Concave Knurls

$p =$ circular pitch of knurl.

Then $r = R + \frac{1}{2} d,$

$C = r + d,$

$A = B + 2 r - 3 d + 0.010 \text{ inch.}$

As the depth of the tooth is very slight, the outside circumference will be accurate enough for all practical purposes for calculating the pitch, and it is not necessary to take into consideration the pitch circle as is done when calculating gears.

Example:—Assume that the pitch of a knurl is 32, that the throat diameter B is 0.5561 inch, that the radius R of the piece to be knurled is 1/16 inch, and that the angle of the teeth is 90 degrees; find the dimensions required for making the knurl.

Using the same notation as above, we have:

$$p = \frac{1}{P} = \frac{1}{32} = 0.03125 \text{ inch,}$$

$d = 0.0156$ (see Table I) inch,

$$r = \frac{1}{16} + \frac{0.0156}{2} = 0.0703 \text{ inch,}$$

$C = 0.0703 + 0.0156 = 0.0859$ inch,

$A = 0.5561 + 0.1406 - 0.0468 - 0.010 = 0.6399$ inch.

Straight concave knurls, when very small, are generally made with a master convex knurl. When the knurls are large enough, a milling cutter with the proper radius is used for cutting the teeth. As it is very difficult to make a concave knurl when the radius is very small, and as the knurl in most cases is not required to be absolutely straight, the

method described in the following for spiral knurls, can be used for making straight concave knurls on the milling machine with teeth in planes practically parallel with the axis of the knurl.

Spiral Concave Knurls

It is, in general, very difficult to cut spiral concave knurls, especially when the radius of the knurl is very small. In Fig. 7 is shown a method which has worked very satisfactorily, and which is also easily accomplished. A hob as shown in Fig. 8 is used, the included angle of the threads of which is made to suit the material to be knurled. The hob is fluted
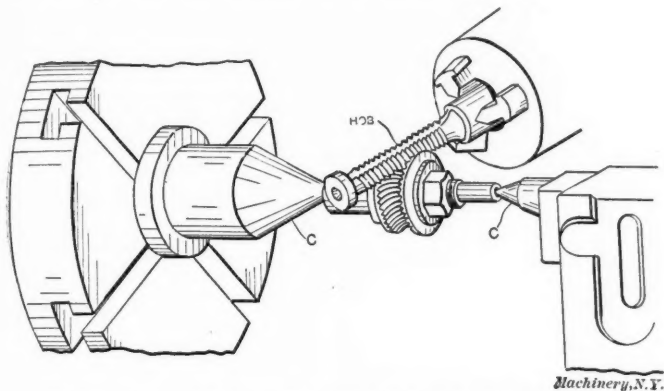
Fig. 7. Cutting a Concave Knurl by a Hob in the Milling Machine

similar to a master tap, excepting that the flutes are not as deep and a greater number of flutes is used. If the hob has more than a triple thread, for instance, the width of the lands should be to the width of the flutes in the ratio 2 to 1. The lead of the hob governs the angle of the spiral on the knurl, and the angle formed by cutting hobs with different leads can be derived, approximately, by means of the following formula:

Let a = angle required,

B = one-half the lead of the thread of the hob,

D = diameter of the hob.

Then $\dfrac{B}{1.5\,D} = \tan a$.
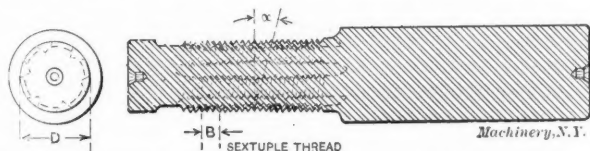
Example:—If a hob has a double thread, the lead of which

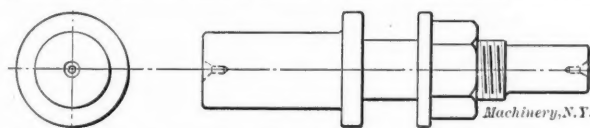Fig. 8. Hob used for Cutting Concave Knurls in the Milling Machine

Fig. 9. Arbor for Cutting Concave Knurls in the Milling Machine

is ⅛ inch, and the diameter of the hob is ¼ inch, find the angle a.

B = ½ of the lead = 1/16, and therefore tan a = 1/16 ÷ ⅜ = 0.1667; a = 9½ degrees.

Cutting a Spiral Concave Knurl in the Milling Machine

It will be seen from Fig. 7 that when cutting a concave knurl in the milling machine, the knurl is held on an arbor shown in detail in Fig. 9. This arbor rotates freely on the centers C, the knurl being held tightly against the shoulder on the arbor by the nut shown. When the knurl has been tightened, the arbor is put between the centers and the table of the milling machine is raised so that the hob comes in contact with the knurl. The machine runs slowly at the start so that the hob will not be forced, but will space the teeth equally. The speed can be increased after the hob has started to cut properly. The hob is held in a chuck provided with a shank fitting the socket in the milling machine spindle. The work should be fed slowly at first, and care should be taken that the arbor rotates freely on the centers, as otherwise the knurl will not follow the lead of the hob properly, and a well-

shaped tooth will not be produced. Care should also be taken to have the diameter of the concave knurl the correct size so that it will contain an even number of teeth, as required by the circular pitch. When the knurl has been cut, the corners should be removed as shown in Fig. 6; then no ragged edges are left on the work, as is the case if the corners are not removed. The table of the milling machine should not be set over when cutting knurls in this manner, but should be left straight.

Designing and Cutting Diamond Knurls

The general methods of using diamond knurls are as follows:

1. When a knurl-holder, as shown in Fig. 10, can be used, a pair of spiral knurls are used, one right- and the other left-handed.

2. When a cross-slide knurl-holder, as shown in Fig. 1, is used, only one knurl can be used, being cut both right- and
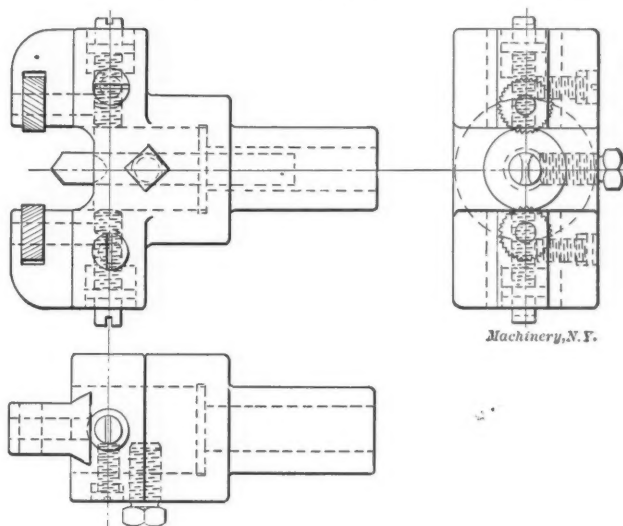

Fig. 10. Turret Knurl-holder for Brown & Sharpe Automatic Screw Machines

left-handed. A knurl cut in this manner would produce a female knurl on the work; so if a male knurl is required on the work, the first knurl is used as a master knurl in cutting the second knurl which will produce a male knurl on the work.

When only the pitch of the knurl required and the angle at which the teeth are cut, as indicated in Fig. 11, are known,
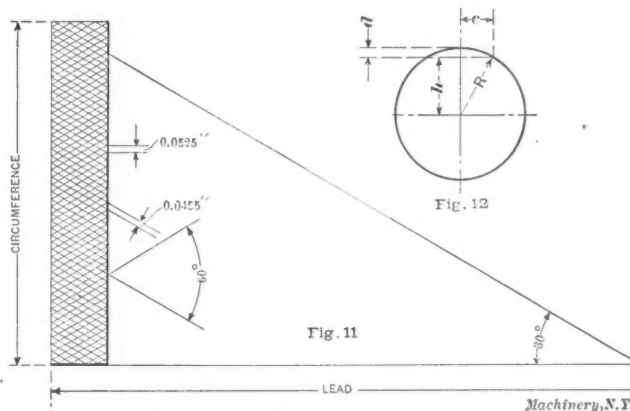

Fig. 11. Diagram for Finding Circular Pitch and Lead of Spiral Knurls.
Fig. 12. Diagram for Calculations Relating to the Feeds of Knurls

then the number of teeth in the knurl must be found and also the spiral lead, as this governs the selection of the change gears used when cutting the knurl.

To Find the Number of Teeth on the Circumference of the Knurl

When the knurl is to form diamond shapes, as shown in Fig. 11, and the included angle is 60 degrees, the number of teeth can be found in the following manner. Let 22 be the normal pitch of the knurl. Then the circular pitch will be 0.0455 inch ÷ cos 30 degrees = 0.0525 inch, and the outside circumference divided by 0.0525 inch will be the number of teeth of the knurl.

To Find the Lead of the Spiral

To find the lead of a spiral of the knurl above, multiply the circumference of the knurl by the cotangent of 30 degrees. Assume that the knurl is 0.752 inch in diameter. Then the circumference equals $0.752 \times 3.1416 = 2.3625$ inches. The knurl has a circular pitch of 0.0525 and the number of teeth therefore equals $2.3625 \div 0.0525 = 45$ teeth. The lead equals $2.3625 \times \cot 30$ degrees $= 4.09$ inches.

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THE RELATION OF DEPTH TO SPAN OF A GIRDER

FRED NEWELL[*]

In designing a girder or cantilever for any purpose where one is not tied to a particular depth by conditions or specification, it is often a matter of trial and error by those whose work or experience does not lead them to a knowledge of what will most surely be the best proportions of depth to span for a given deflection and stress. Even where one's knowledge of these proportions is of the best, the following table will prove a help in the first considerations of a design. It must, however, be remembered that the table is only of use where the girder is symmetrical in section about its neutral axis, and for a modulus of elasticity of 29,000,000, which is very general for structural shapes. The deflections used for calculating the table are those in most general use, being 1 inch per 100 feet span or $\dfrac{L}{1200}$, and 2 inches per 100 feet span or $\dfrac{L}{600}$, L being in inches. The lower limit is used where stiffness is necessary, and the higher limit where stiffness is not of primary importance.

If the modulus of elasticity is other than that taken in these calculations, the divisor of the expression in the last column of the table will be directly proportional to the value of the modulus. For each condition of loading, the divisor is inversely proportional to the assumed safe stresses.

To arrive at the results the writer has combined the bending moment formula $M = \dfrac{fI}{y}$, with the deflection formula

$$\delta = K\frac{WL^3}{EI}, \text{ where}$$

$M =$ bending moment,
$f =$ safe allowable stress,
$I =$ moment of inertia of section,
$d =$ depth of girder or cantilever,
$y =$ distance of neutral axis from outer fiber $= \dfrac{d}{2}$ for symmetrical sections,
$W =$ total load,
$L =$ length of span,
$\delta =$ deflection,
$K =$ constant depending on loading and support.

All dimensions are in inch-pound units. For example, take the simple case of a cantilever loaded at one end, and let $\delta = \dfrac{L}{1200}$, and $f = 10,000$ pounds per square inch.

$$M = WL = \frac{fI}{y} = \frac{2fI}{d};$$

$$\delta = \frac{WL^3}{3EI} = \frac{2fIL^2}{3EId} = \frac{2fL^2}{3Ed};$$

but $\delta = \dfrac{L}{1200}$; therefore $\dfrac{2fL^2}{3Ed} = \dfrac{L}{1200}$,

and $d = \dfrac{2400fL}{3E} = \dfrac{2400 \times 10,000 \times L}{3 \times 29,000,000} = \dfrac{L}{3.625}$

$$d = \frac{L}{3.625} = 0.276\,L.$$

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Having arrived at the required depth for a given deflection, it is an easy matter to find a suitable section for the given

RELATION BETWEEN DEPTH OF GIRDER AND LENGTH OF SPAN.

$L =$ length of span in inches.

Conditions.	Safe Stress, Pounds per Square Inch.	Depth, Inches.
Beam supported at ends; load concentrated at middle; deflection, $L \div 1200$ or 1 inch per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 14.5$ $L \div 11.6$ $L \div 9.05$ $L \div 7.25$
Beam supported at ends; load concentrated at middle; deflection, $L \div 600$ or 2 inches per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 29$ $L \div 23.2$ $L \div 18.1$ $L \div 14.5$
Beam supported at ends; load uniformly distributed; deflection, $L \div 1200$ or 1 inch per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 11.6$ $L \div 9.3$ $L \div 7.25$ $L \div 5.8$
Beam supported at ends; load uniformly distributed; deflection, $L \div 600$ or 2 inches per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 23.2$ $L \div 18.6$ $L \div 14.5$ $L \div 11.6$
Cantilever; load concentrated at end; deflection, $L \div 1200$ or 1 inch per 100 feet.............	12,000 12,500 16,000 20,000	$L \div 3.625$ $L \div 2.9$ $L \div 2.27$ $L \div 1.81$
Cantilever; load concentrated at end; deflection, $L \div 600$ or 2 inches per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 7.25$ $L \div 5.8$ $L \div 4.54$ $L \div 3.62$
Cantilever; load uniformly distributed; deflection, $L \div 1200$ or 1 inch per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 4.83$ $L \div 3.87$ $L \div 3.08$ $L \div 2.42$
Cantilever; load uniformly distributed; deflection, $L \div 600$ or 2 inches per 100 feet.............	10,000 12,500 16,000 20,000	$L \div 9.66$ $L \div 7.74$ $L \div 6.06$ $L \div 4.84$

stress; but in all cases where exact work is required, the actual deflection and stress should be obtained after the design has been completed.

* * *

The United States government inaugurated a plan two years ago for the purchase of coal on its heating value. At the present time there are forty departmental buildings in Washington, the Panama Railroad, more than three hundred buildings throughout the United States, navy yards and arsenals buying coal on specifications, the prime element of which fixes the amount of ash and moisture. Premiums are paid for any decrease of ash below 2 per cent at the rate of one cent per ton for each per cent. Reductions are made at an increasing rate for each per cent of ash when it exceeds the standard established by two per cent. The advantages of buying coal on these specifications are: bidders are placed on a strictly competitive basis, as regards prices and qualities; the field for both the government and the dealers is broadened, as trade names are ignored and comparatively unknown coals offered by responsible bidders may be accepted; the government is insured against poor and dirty coal and is relieved of disputes arising from condemnation on the usual visual inspection; experience with the old form of government contract is not always expedient to reject poor coal because of the difficulty, delay and cost of removal. Under the present system rejectable coal may be accepted at a greatly reduced price.

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CORRECTION

A transposition of the titles of Figs. 41 and 42 occurred in the article on the Chicago and Northwestern Railway shop practice, published in the May number of MACHINERY. It should also be stated that the practice referred to as the company's method of boring piston rings, is instead its method of boring bushings for cylinders.

INCREASING THE EFFICIENCY OF A HORIZONTAL DRILLING, TAPPING AND BORING MACHINE

ALFRED SPANGENBERG[*]

A machine tool may be installed to handle work of a specific character and for the sake of economy in first cost it is frequently deemed advisable to select a standard type of simple design, and embodying only such features as are necessary for the work intended. Subsequently, if occasion requires, aditional features can be provided that will adapt the machine for a variety of work. The accompanying engravings illustrate a motor-driven, horizontal drilling, tapping and boring machine, and show a number of features that were recently added by the writer. This machine originally was designed for a class of work that would require comparatively short adjustments of the column, and therefore was provided with a hand ratchet movement.

The changes made were: Substituting a rapid power traverse for the column to enable quick adjustments on long
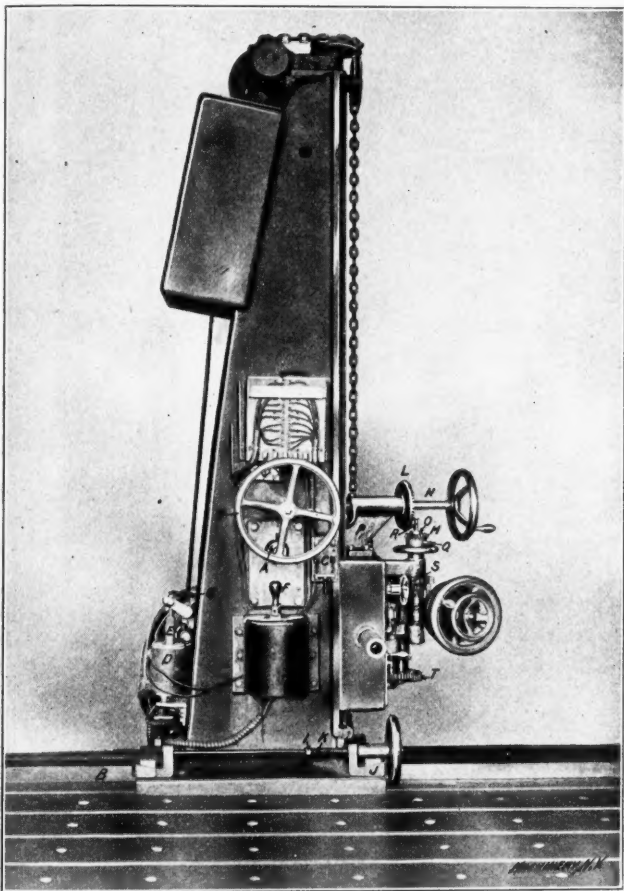

Fig. 1. Horizontal Drilling, Tapping and Boring Machine equipped with Power Traverse for the Column, Power Feed for the Head, New Clamping Devices for Column and Head, etc., to increase its Efficiency

work; providing a power feed for the head so that the machine could be used for milling; a new clamping arrangement for the column and also for the head, thus discarding open end wrenches and facilitating the clamping and loosening; providing means for shifting the sliding feed gears while the machine is running; and attaching a brass speed index plate to the controller and a pointer on the controller lever. This used in connection with a table of cutting speeds and feeds stamped on the brass plate shown fastened to the resistance box, provides the operator with a standard guide and eliminates all guess work as to the proper speed and feed for cutters of various diameters. The problem of applying features which are not in the form of standard attachments to a machine, and therefore were not contemplated in the original design, accounts for some of the devices appearing rather crude. The chief interest, however, lies in the fact that very little expense was involved, since the gears, handwheels and levers were taken from stock parts belonging to other machines.

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A study of the engravings, Figs. 1 and 2, will make clear the application of the rapid power traverse for the column. Shaft A, Fig. 1, originally carried the ratchet wrench, and transmits motion through bevel gears and a vertical shaft inside the column, to a rack pinion meshing with the rack B. For the purpose of deriving power from the motor, this shaft was replaced by a longer one that extends through the column and is also represented by the letter A in Fig. 2. Keyed to it is the spur gear B into which mesh the handwheel shaft pinion C and also the compound gearing driven by the pulley
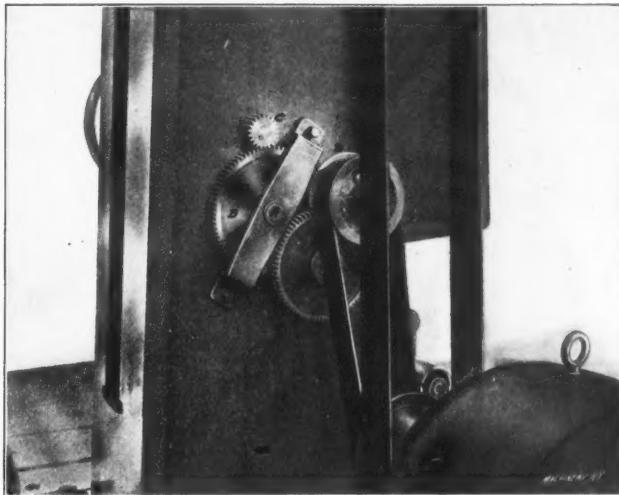

Fig. 2. Motor connected with Mechanism for the Column Traverse

D. A belt that normally is loose, connects the pulley D with the motor pulley. The line engraving, Fig. 3, shows the method of fastening the latter onto the motor shaft. This was accomplished without removing the motor shaft by holding the drill in a ratchet wrench and feeding it in while the motor was running.

When it is desired to traverse the column by power, the belt is tightened by closing the switch C (Fig. 1) which energizes the magnets D and they in turn bring the idler pulley E into position by means of the U-shaped magnet core, levers and shaft shown in the engraving. The column now can be run in either direction by operating the controller handle F. Spring G takes the weight of the magnet core and lever when the magnets are inactive. Final adjustment of the column is made with the hand-wheel H. The object of the belt drive was to avoid any accident, should the switch inadvertently be left closed and the motor started with the column clamped;
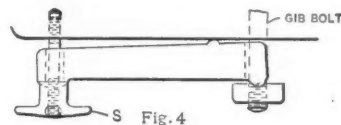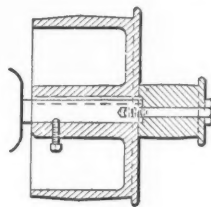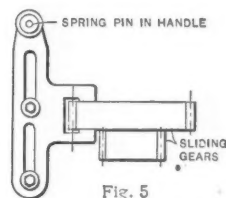

Fig. 3. Method of Fastening Rapid-traverse Driving Pulley on Motor Shaft. Fig. 4. Device for Clamping the Head without a Wrench. Fig. 5. Trunnion with Handle for Shifting the Feed Gears

and the sole reason for using the magnets was because they were a pair belonging to a discarded magnetic clutch planer drive. It will be observed that the idler pulley bracket cuts off some of the travel of the counterweight. This is of no consequence, however, as this particular machine never has to handle work requiring the head near the top of the column.

The power feed for the head consists of the bevel gear L and sliding bevel pinion M. The axis of shaft N originally did not intersect with that of the vertical feed shaft O, and necessitated resetting the bracket P. A spring pin Q keeps the bevel pinion in mesh with the bevel gear when it is desired to feed the head by power. It was also necessary to

lengthen the pull spline shaft *R*. A crank wrench on the outer end of shaft *N* was superseded by the hand-wheel shown and the latter proved to be much more convenient. As stated previously, the primary object of a power feed for the head was to provide a feed for milling work, but when the spindle back gears are out, and the fast feed used, the adjustment of the head by power is quite rapid.

The clamping arrangement for the column is clearly indicated in Fig. 1. As will be seen, the clamping bolts are inverted and their heads beveled to fit the angle on the wedges *J*. Screwed on to the threaded end of each bolt is a block fitting the T-slot in the base plate. The hand-wheel sleeve is threaded to fit the tie-rod and the wedges act on the bolts by this means. Between the collar *I* on the tie-rod and the wedge *J* is a spring *K* which tends to keep the wedges loose when the hand-wheel is slackened off. Two turns of the hand-wheel is sufficient to clamp the column.

is the practice to use universal joints for driving the cutter bars to avoid accurate setting of the jig; the machine only being used as a means for driving and feeding the bars and the jig acting as a guide. It must not be inferred, however, that this type of machine will not do accurate work without the use of jigs. As a matter of fact, the jig in question and nearly all of the jigs illustrated in the article above referred to were bored on a similar machine. For this work an adjustable outboard bearing is provided to support the end of the boring-bar. These machines were built by the Pond Works of the Niles-Bement-Pond Co.

* * *

Recent correspondence in the *Engineering News* attributes the disintegration of concrete work in sea water to alternative freezing and thawing. It has been noted that this disintegration occurs only in that portion of the concrete which is between the high and low tide levels, being to this extent sim-
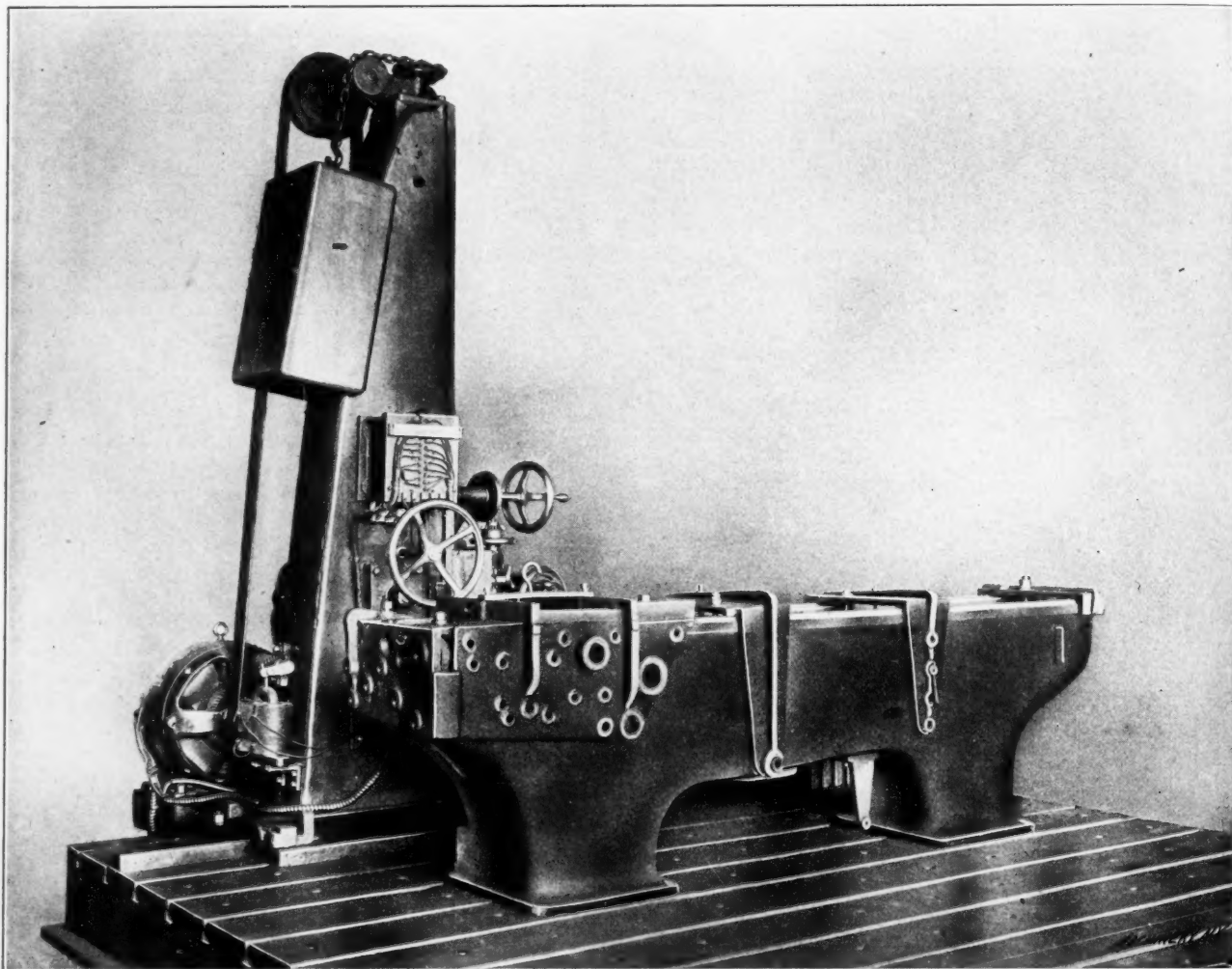

Fig. 6. Twenty-one-inch Pond Rigid Turret Lathe Bed, with Jigs in Place, ready to be drilled

The line engraving, Fig. 4, shows the device for clamping the head to the column; the design is so simple that no explanation is necessary. The knob *S* is represented by the same letter in Fig. 1.

Means for sliding the feed gears *T* (Fig. 1) is shown in detail in Fig. 5. These gears formerly were shifted directly by hand and held in place by a spring-pin that entered a groove in the shaft. The advantages of the new device at once are apparent.

An idea of the class of work this machine will handle to advantage is obtained from the half-tone, Fig. 6, which shows a 21-inch Pond rigid turret lathe bed with the jigs in place ready to be drilled, bored and tapped. Four settings of the bed are necessary, as there are holes in both sides and ends. On work of this character the rapid power traverse is especially valuable. It will be of interest to note that this machine is also used to bore the head-stock for the bed just referred to. The head-stock and its jig was shown in Figs. 132 and 134 in the article on Jigs and Fixtures which appeared in the February issue of MACHINERY. For work of this character it

ilar to the decay which takes place in piling under the same conditions. It has been found that this disintegration takes place in winter. At high tide the water penetrates the minute pores in the surface. As the tide lowers, this absorbed water freezes, expanding as it does so, and loosening the surface of the concrete. When it is again submerged, it again thaws, and a new supply of water enters the pores, so that the loosening process is repeated at the next tide. It is suggested that the concrete work be covered with a cement facing mortar; or better yet, that all the cement used in concrete laid below the watermark be thoroughly waterproofed, either by a patented compound or by the admixture of clay. Concrete which is not exposed at low tide is perfectly safe from disintegration.

* * *

An inventory of the resources of natural fuel represented by the peat deposits of the United States has been made by Prof. Charles A. Davis of the United States Geological Survey, who estimates that the bogs and swamps of the United States contain approximately 13,000,000,000 tons of peat, representing a value of $38,000,000,000.

LOGARITHMIC PAPER FOR DIAGRAMS

J. NORMAN JENSEN*

Engineers may be divided into two classes, i. e., those who use diagrams to aid them in their work, and those who do not. The latter class will impatiently pass over any article or book in which a curve is used to express the relation between two or more variables. Some of these men detest a diagram more than they detest the curling tail of an integral sign. If diagrams are not too complicated they have, however, a certain place in business and in engineering. In most modern offices the fluctuation of prices in different commodities is shown graphically so that one can tell at a glance the general tendency of the market at any time. In the office of the manager, the shop foreman, or the timekeeper, diagrams showing the relation between wages and production are of great value as by means of them "leaks" can readily be discovered.
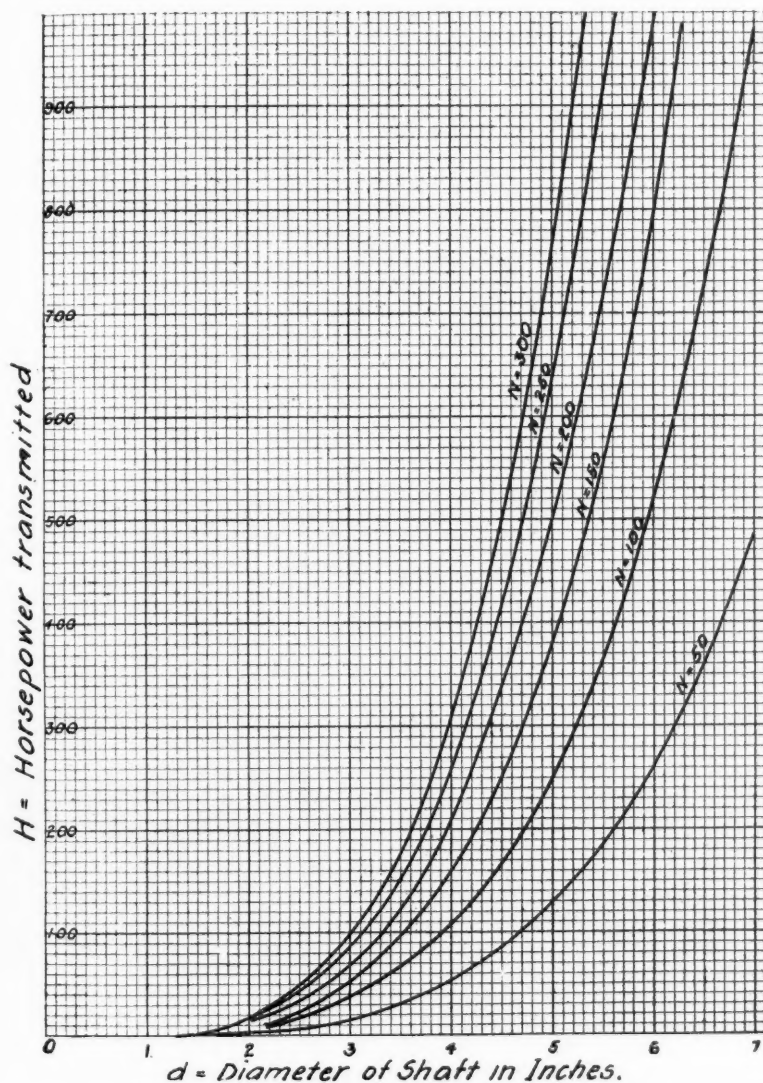
5. Divided both ways, logarithmic, 1 to 100.

In science and engineering the law of variation in quantities is usually expressed as an equation. When this equation is of the first degree, it is graphically plotted on cross section paper as a straight line. When the variable enters in any other power or root than the first, a curve results. On ordinary squared paper, plotting a curve is very laborious as a great many points must be found in order to obtain the shape of the curve. In tracing a curve through the plotted points it is difficult to obtain a draftsman's irregular curve which will "fit," and as a result the curve as drawn is only correct at the plotted points.

When the equation has the form $x = a y^m z^n$, in which the exponents m and n are of any power or any root, logarithmic paper has a distinct advantage over ordinary squared paper. As its name implies it is divided logarithmically, that is, the distances of the abscissas and the ordinates from the origin
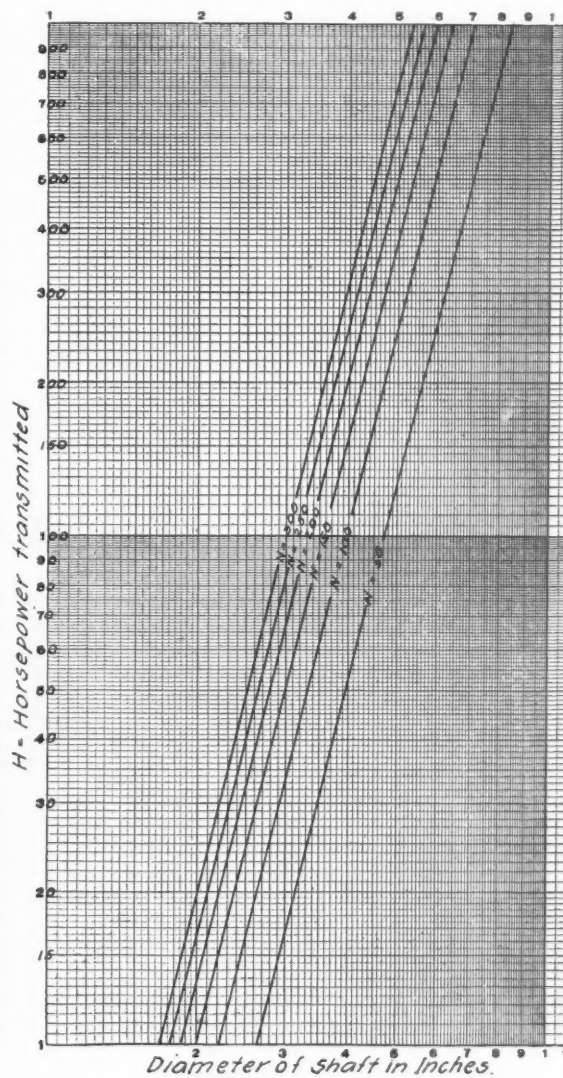

Fig. 1. Horse-power and Shafting Diagram Plotted on Regular Cross-section Paper

Fig. 2. The Same Diagram as in Fig. 1 laid out on Logarithmic Paper

It is the engineer, however, who uses and appreciates diagrams most. Oftentimes a row of figures does not tell very much, but when these same figures are plotted on cross section paper, a picture is obtained which clearly brings out the law of variation of the quantities involved. Another thing which may be said in favor of diagrams is that they are great time-savers. To the busy man this is the principal advantage.

The cross section paper on the market is ruled in the following ways:

1. Divided horizontally and vertically into centimeters and millimeters.

2. Divided horizontally and vertically into inches and eighths or tenths of an inch.

3. Divided horizontally into inches and tenths, and vertically, logarithmic, 1 to 10.

4. Divided both ways, logarithmic, 1 to 10.

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are proportional to the logarithms of the numbers instead of the numbers themselves. The principle on which it is based will be readily understood by those familiar with the slide rule. In fact a slide rule can be made by anyone by merely setting the edges of two sheets of logarithmic paper in the proper position.

In order to compare logarithmic with ordinary cross section paper the accompanying diagrams were prepared. The curved lines are plotted on ordinary paper, the straight lines on logarithmic paper. The range of values is the same in both sets of curves.

The equation used is one in which the diameter of shafting is obtained by the formula $d = c \sqrt[4]{\dfrac{H}{N}}$ in which

d = diameter of shaft in inches.

H = horse-power transmitted.

N = number of revolutions per minute.

c = a constant.

For long steel shafts c is usually 3.96. The equation which

is to be plotted is $d = 3.96 \sqrt[4]{\dfrac{H}{N}}$

For any particular curve N is a constant, so that all that is necessary to do is to solve for H with any given value of d. A numerical example may make this clearer. Take $N = 200$, $d = 2$ inches; then $H = 13$. Again, take $N = 200$, and assume $d = 5$; then $H = 508$.

On ordinary squared paper for any assumed value of N a large number of values of H and d must be found in order to obtain the true form of the curve. When completed, the curves thus plotted are unsatisfactory as they all approach the origin, so that they bunch together in a way that is annoying when calculations are involved wherein results near the origin are sought. In this particular instance the curves converge at the points where the diagram is most likely to be used.

Logarithmic paper reduces the labor of computation. All that is necessary is to plot two extreme points and draw a straight line connecting them. The equation is truly represented by this line and each point on this line is correct. To test the accuracy of the work an intermediate point may be calculated, and plotted on the diagram. If it falls on the line already drawn the work is correct. If it does not fall on this line, some mistake was made in calculating one or both of the end points.

To illustrate the use of logarithmic paper take the data previously calculated. Plot the point corresponding to $d = 2$, $H = 13$. In same way plot point $d = 5$, $H = 508$. Draw a straight line between the two points. This establishes the curve for $N = 200$. As a check it will be found that the point $d = 4$, $H = 208$ falls on the line drawn, showing that the end points were correctly plotted.

On plotting these different values of N on logarithmic paper it will be noticed that all the curves are parallel. This in itself is a check on the accuracy of the work, as a lack of parallelism in the lines indicates that something is wrong, so that the use of logarithmic paper in itself is a guard against inaccurate work. The directions given above are general for any equation of the form $x = a y^m z^n$. For any particular curve, y^m or z^n is a constant, and as a is a constant, the equation resolves into $x = k y^m$. Logarithmically expressed, the last equation becomes $\log x = \log k + m \log y$. This logarithmic equation is really the same as the equation $x = a + by$, an equation of the first degree, and explains why the curve becomes a straight line on logarithmic paper.

It will be readily seen that where a great many diagrams are to be made, this paper is a time-saver. It may be used for purposes of calculation in ways which will suggest themselves to the ingenious man. Among the more common uses to which it may be put are the following: Powers and roots of any and all indices; bending moment, shearing stress, or deflection of beams in terms of span or load; moments of inertia and radii of gyration in terms of a linear dimension; circumferences and areas of circles in terms of their diameters; sizes of bars, struts, shafts, etc., in terms of a linear dimension; hydraulic equations, etc.

* * *

Consul William Bardel of Rheims reports that a new French plate glass has been brought out which is practically burglar-proof. While an ordinary plate glass, such as is usually put into jewelers' show windows, can be smashed by a single stroke of a metal-faced mallet, it is not possible to break this new plate glass in this manner. In an experiment made, a large piece of cast iron was thrown violently against the window, but the only effect on the glass was a small hole measuring one or two inches. Several shots of a revolver loaded with jacketed bullets were then fired at the show window, but the window suffered no damage except that the bullets entered to a depth of a fraction of an inch. The plate glass which will stand such usage is ordinarily made of a thickness of ⅞ to 1 inch. If desired, even a heavier glass can be made without diminishing the transparency.

CENTRIFUGAL PUMPS

JOHN B. SPERRY[*]

Under the above title in the February issue of MACHINERY Mr. E. N. Percy writes as follows: "The common commercial volute pump seldom gives over 45 per cent efficiency, but can easily be designed to give 65 per cent and can be manufactured just as cheaply." This statement would have been true six years ago, but the manufacture of centrifugal pumps has improved greatly since then. Instead of using a rough runner in between the halves of a split casing, also without machined surfaces, and calling it a pump, the runners are machined thoroughly to gage and then accurately balanced to insure smooth running; the casing or volute is cast in one piece and machined to gage; the covers are also machined to gage. The bearings of the modern centrifugal pump are of the ring or chain oiled type, machined and babbitted to gage.

When Mr. Percy states that the volute pump seldom gives over 45 per cent efficiency, I think he is rather severe on that style of pump. I have copies of tests of five 4-inch centrifugal pumps of the volute type, no two of which were built by the same manufacturers. These tests were run at different speeds and covered heads ranging from 20 to 75 feet. The efficiency of all of the pumps was above 60 per cent and ran as high as 72 per cent. The maximum efficiency in these pumps varies according to the design. For one it comes at 25 feet, for another at 40 feet, and another at 60 feet. The efficiency on either side of this maximum decreases very slowly, and for this reason the patterns of

A Two-Stage Pump for Deep-well Work

these pumps are applicable to a wide range of heads, provided the speed is properly arranged. It might be of interest to add that it is customary by one manufacturer to guarantee at least 70 per cent on volute pumps 6 inches and larger; and 75 and 80 per cent on those 30 inches and larger. That he lives up to his guarantee is shown by his increasing business in pumps. Mr. Percy also states that European pumps give a higher efficiency than American pumps. In answer to this, I can cite instances where American pumps are taking the place of European pumps in Porto Rico and elsewhere. I also know of cases where pumps are being manufactured under European patents and the manufacturer does not dare to guarantee even as high an efficiency as that of some of the manufacturers of the volute pump, which type Mr. Percy considers low in duty.

Mention was made of the electrically-driven, deep-well, multistage pumps which are now coming into use. The accompanying engraving illustrates a pump of this character that has been developed during the last two years by the American Well Works. The engraving shows a two-stage pump with a balancing chamber, or water step at A. This water step receives its pressure from the discharge side of the pump through the port B. The down thrust is still further relieved by the design of the runner, as shown at C. By this construction the suction pressure is admitted to the top of the runner, and the discharge pressure at the bottom; the difference in the two total pressures assists in floating the rotating member of the pump. Surrounding the shaft F is a tube E which forms a support for the guide bearings of the shaft and protects them from any sand that may be in the water. Outside of this and concentric with it is a larger tube that supports the pump from the top of the well. The annular space between the two tubes forms the discharge pipe. This type of pump is adapted for pumping from deep wells where a large quantity of water is required, such as city waterworks, factories, ice plants, railroads, mines and irrigation projects.
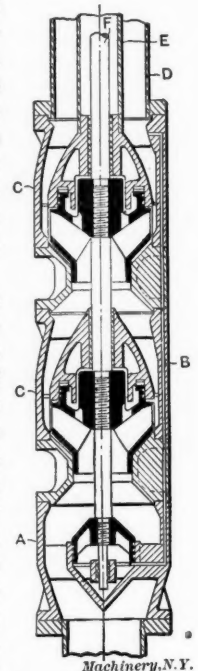
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DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—6

BRACED GIRDERS

R. B. BROWN

Reference was made on page 669, May issue, to the three types of braced girders commonly in use, of which the Warren type is the most suitable for ordinary traveler work. The details of construction of this type differ somewhat according to the size and span of the crane, but the nature and magnitude of the stresses, which have to receive primary consideration, are found by the same methods in all cases.

In order to become thoroughly familiar with this type of girder, it is best to study its construction "anatomically." Fig. 28 shows the outline of the construction of a Warren girder consisting of a compression flange AA', and a tension flange ADD'. These flanges are kept in position by the diagonal struts BD, BE, CE, CF, etc., which are subjected alternately to tensile and compressive stresses as the position of the load varies. Apart from the compression in the top flanges, due to the maximum bending moment, there is an additional force, due to the bending moment in the top flange caused by the load of the crab wheels. In order to minimize this quantity the vertical members GD, HE, IF, etc., are added, thereby reducing the effective spans in the top flange by one-half. Girders of this type are made either parallel (Fig. 28), or fish-bellied, as shown in Fig. 29. The former have a satisfactory appearance and do not need to be made so heavy at the ends as the latter; they are cheaper to make, owing to the fact

In designing girders of this type there are three distinct processes, as it were, to be gone through: 1. Draw an outline of the proposed girder, fixing the depth and number of bays; 2. Find the stresses which occur with the load in various positions in each member; 3. Select suitable sections to withstand the various stresses found.

Let Fig. 31 represent the outline of a Warren girder for a 15-ton crane of 72-foot span, weight of crab 5 tons, and centers of runners 6 feet. The most economical depth of these
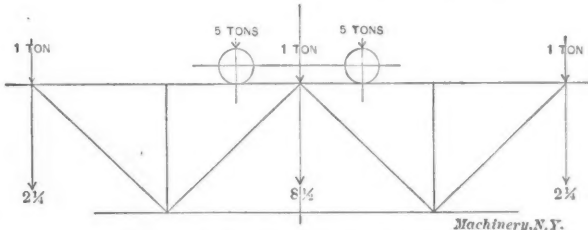

Fig. 30. Enlarged Portion of Girder in Fig. 31

girders in relation to the span has been found to be about 1/12, so that in the present example the depth may be taken as 6 feet. It is preferable (but not essential) to divide the girder into an even number of bays on the top flange. No definite rule can, however, be given for the angle of the diagonals, which may be found to vary from 45 degrees in the case of light cranes to 60 degrees in those of heavier construction, but it is not economical to make the angle much less than 45 degrees. Other things being equal, the principal object is to have as few members as possible, and this result is generally
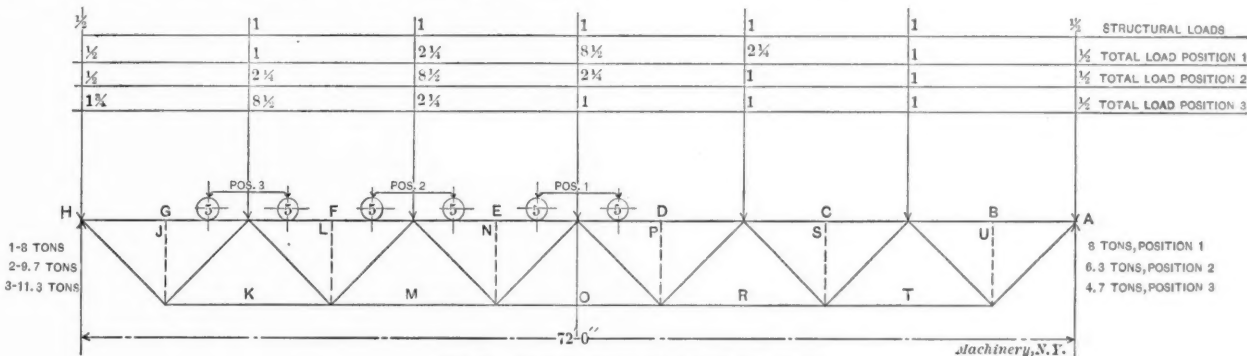

Fig. 31. Warren Crane Girder, 72-foot Span

that the lower flange does not need to be bent, and one set of templets will in some crabs suit all the diagonals. The fish-bellied form is, however, often preferred and is sometimes most convenient and will, therefore, be considered also.

The stresses in the various members may be found either by moments or by diagrams. The former method is somewhat tedious and not often adopted, except perhaps for finding the maximum flange stresses for comparison purposes, or to
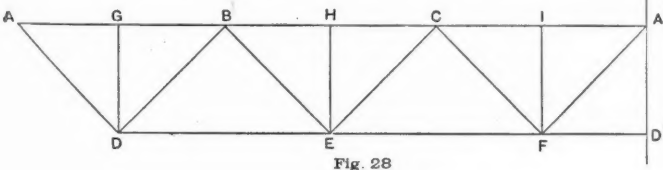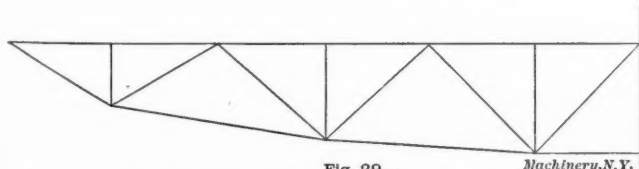

Fig. 28

Fig. 29

Fig. 28. Warren Type Girder, Parallel Construction.   Fig. 29. Warren Type Girder, Fish-bellied Construction

check the diagrams. If the stress diagrams are carefully drawn, the forces given will be sufficiently accurate for practical purposes. It is not within the scope of this article to prove the methods employed, since such can be done by referring to the various works on girder construction, the principal object being to take an example of each particular type and show the quickest methods of obtaining those results which directly concern the designer.

gained by making the included angle of the diagonals as large as reasonable. There is, however, a limit to economy in this direction, which is reached when the span of the unsupported lengths of the top flange become so long as to require abnormally heavy sections to resist the combined bending moment from the crab wheels and compression in the girder itself. This quantity can only be settled by trial or comparison. In the example it will be seen that the top flange has been divided into six bays of 12-foot centers, the unsupported length being reduced to 6 feet by the insertion of the vertical struts. From the above figures it will be seen that the angle of the diagonals is 45 degrees, which represents a fair average for girders of this size.

The outline of the proposed girder is now complete, but before proceeding it is necessary to call attention to the fact that when possible the line drawn through the center of gravity of the various members should intersect at the same point, as in the case of the outline diagrams from which the stress diagrams are drawn. This precaution is necessary in order to minimize the secondary forces, which, although of no importance in small cranes, are sometimes considerable in heavy work; the girders and templets are also much more easily "set off" under these conditions. Before the stress diagram can be drawn, the loading of the girder must be considered, and it will be necessary to assume the weight of one girder together with its platform and cross-shaft.

In the present case this quantity may be taken at 6 tons, and since the girder will be of practically uniform construction, is equal to one ton per bay. The loading on the various bays from the crab wheels must be found by assuming the crab to be in the position shown in Fig. 30, where it would give the greatest reaction on any diagonals.

The effect of the above loads can be found from the skeleton diagram shown in Fig. 31. The first diagram is drawn for the loads as they occur when the crab is at the center of the girder. In reaching the loads from the crab wheels on to the apices of the various diagonals, no notice is taken of the intermediate vertical struts. This is not quite correct, since the vertical members convey part of the load direct to the bottom flange, but, as the inaccuracy is of little importance for small girders, it is simpler to eliminate the vertical struts from the diagrams altogether.

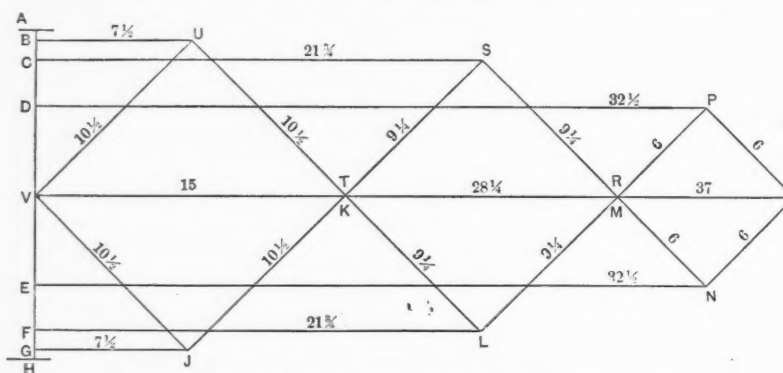The first diagram for the load in the center is commenced by drawing the line AH, Fig. 32, which is the load or base

scaled off and written in the skeleton diagram for reference.

In the case of small cranes, it will generally be found most economical in practice to make all the diagonals of one, or, at the most, two sections, since the difference between the maximum and minimum loads is not great, and when this is done, it is only necessary to draw one diagram in the center as shown in order to get the maximum flange stresses, and another with the load in a position near the end as shown in Fig. 33 to obtain the maximum diagonal stresses. When, however, the girders for cranes above 20 tons are being designed, it is better practice to find the maximum stresses occurring in each member and proportion the sections to suit;
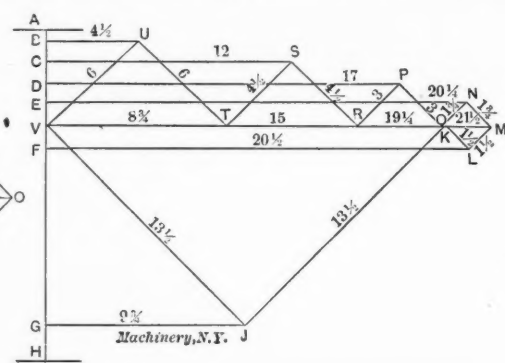

Fig. 32. Stress Diagram for Crane Girder in Fig. 31, Load in Center

Fig. 33. Stress Diagram for Crane Girder in Fig. 31, Load in Position 3

line of the diagram. From A set off the distance AB equal to 0.5 ton at any convenient load scale, say, ¼ inch = 1 ton. This quantity represents the structural load acting directly over either abutment. Similarly, make BC = 1 ton, CD = 2.25 tons, DE = 8.5 tons, EF = 2.25 tons, FG = 1.0 ton and GH = 0.5 ton. Bisect AH at V, and draw a horizontal line through this point, as shown. The distance VA, or VH (8 tons) will be equal to the reactions at either point of support. The loads AB and GH are only set off on the load line to make the

and this will be done in the present case, in order to show the method used.

In drawing the diagram, Fig. 35, for position 2, Fig. 31, the load line will be drawn as in position 1, with the order of loading, in accordance with the re-distribution of loads as in the skeleton diagram, Fig. 31. The reactions at the abutments from both the rolling and structural loads must be found in the usual way, and set off on the load line as shown. From V draw a horizontal line and then draw the diagonal stress
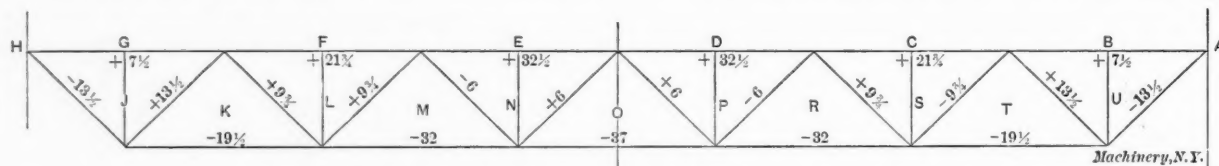

Fig. 34. Stresses in Crane Girder in Fig. 31, as determined by Stress Diagrams

reactions complete, because, since they are directly over the abutments, they do not have any direct influence on the stresses of the structure itself.

From V draw a line VU parallel to the diagonal members in the skeleton diagram, producing same until it intersects a horizontal line drawn from B at U. Then the force in VU can be read off this line to the same scale as that adopted for the load line. Similarly draw UT, TS, SR, etc., parallel to their respective members in the skeleton diagram.
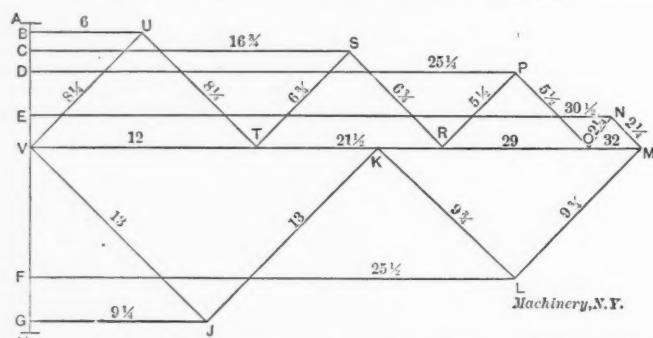

Fig. 35. Stress Diagram for Crane Girder in Fig. 31, Load in Position 2

When the diagram has been drawn on one side, the opposite side may be duplicated if required, since the loading is symmetrical. When the diagram is completed, the letters on the force diagram correspond to those given on the skeleton. Thus, the maximum tension in the lower flange occurs at the center and is equal to VO, while the maximum force in the diagonals occurs at U or J and equals VU, VJ, UT, and JK. The various stresses occurring in each member have been

lines as in the previous example. If the diagram is correctly drawn, the last force line will join at the starting point V, thereby checking itself, but it should be borne in mind that unless the position of V is exactly to scale, the diagram will not close and cannot be considered correct.

The stresses are found when the load is in position 3, as shown by the diagram, Fig. 33; this process could be repeated for any number of bays.

Since there is no definite relation between the centers of the crab wheels and the pitch of the diagonals, it is difficult to say beforehand whether the loads in the positions already considered give the maximum stresses on the diagonals; generally speaking, they do, but in heavy cranes it is better to make certain by drawing another set of diagrams for other positions. Having found the stresses arising from the loads in the various positions, it is convenient to record the highest stress found on any diagram for any particular member, on another skeleton diagram, as shown in Fig. 34.

Under certain conditions, it might have been preferable to make the above girder fish-bellied in form, as previously referred to, and, in order to make this treatise complete, the diagrams shown in Figs. 36 and 37 have been drawn to suit the altered design. The diagrams are constructed in precisely the same manner as in the previous example, the only exception being that the force lines for the lower flange must be drawn parallel to their corresponding members. By comparing these diagrams with those for the parallel girders, it will be seen how unsuitable, comparatively speaking, the fish-bellied girder is, for at the point where the diagonals have the maximum stress, they are inclined at the smallest angle, and consequently receive the greatest possible stress

which, generally speaking, is so heavy that sufficient rivets cannot be put into a suitable strut, and web plates, or very large gusset plates, must be used. The stresses in the end struts may be minimized by shortening the length of the bays at the ends, as shown in Fig. 37.

The corners or sets on the lower flange do not form a parabolic line as may be the case in a plate girder, but are more a question of practical judgment, the main object being to make the end bays as deep as possible. In details of construction this girder is practically the same as the parallel type.

When the stress sheet is finished, the designer may pass on to the first operation of selecting suitable sections to withstand the strains. There are four different types of girder sections commonly in use, as shown in Figs. 38 to 41. The
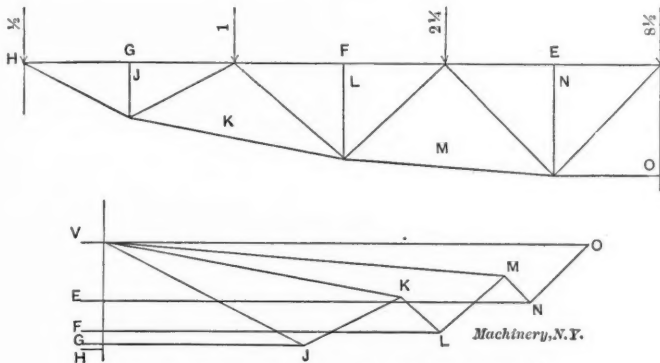

Fig. 36. Stress Diagram of Fish-bellied Girders

type shown in Fig. 38 is suitable for cranes up to 3 tons capacity, and over 40 feet span, when no platforms are specified, as in the case of small cranes worked from the floor level. By placing the channel forming the top flange horizontal, as shown, the girder receives the necessary lateral stiffness in the right place, and, since the wheel pressures are light, there is always sufficient strength to resist bending in the other direction.

When platforms are required, and for all cranes above 3 tons and up to 20 tons, of more than 65 feet span, the construction shown in Fig. 39 has been found suitable. Lateral strength is given to this type by the addition of braced platform girders. For cranes of 25 tons capacity and upwards, and over 65 feet span, the box-latticed types shown in Figs. 40 and 41 are most suitable. The channel construction shown in the top flange of Fig. 41 generally becomes necessary for
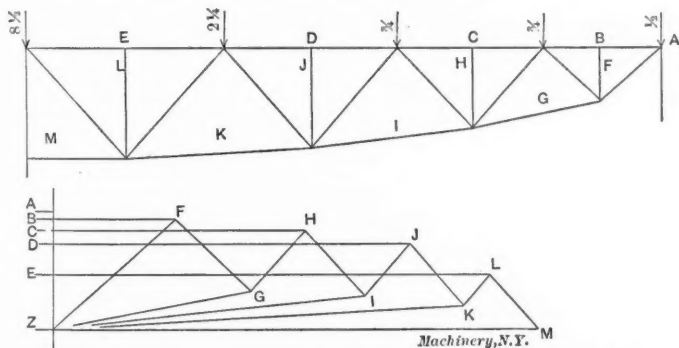

Fig. 37. Length of Bays at End of Fish-bellied Girders Shortened to equalize Stresses in Struts

cranes of 40 tons capacity and upwards. When these types are used, it is cheaper to make the girders strong enough laterally, and attach ordinary platform brackets, as shown, although this arrangement is not suitable for high speeds. The type of girder used in the previous example will be the same as shown in Fig. 39.

The scantlings of the bottom flange can be determined without difficulty, since no lateral stiffness has to be provided for in the girder itself. The width of flanges becomes principally a question of convenience, adding a rail and web to suit the top flange, as shown in Fig. 42. It will be seen that in this case the rail has been riveted on continuously in such a manner that it can be regarded as a useful part of the section.

As a preliminary guide in assuming a suitable section, the designer may select such sizes as will give an area which will correspond to not more than from 2 to 3 tons per square inch. The depth of the web varies according to the load, but is generally proportioned to suit the riveting of the diagonals. When the section has been assumed in this manner, the next step is to find the modulus in the usual way.

Draw the section full size, and from the vertical line AB, drawn parallel to the center of the section, set off the net section, as shown in Fig 42. Determine the center of gravity in each piece, together with its area. When these particulars have been fixed, the center of gravity of the whole mass may be found in the ordinary way, by multiplying the area of each piece by the distance from AC to its center of gravity, and dividing the sum of these products by the total area of the section, thus:

Section 1. $2.2500 \times 0.5625 = 1.2656$
2. $1.1250 \times 1.6875 = 1.8984$
3. $1.2187 \times 2.4375 = 2.9707$
4. $3.8437 \times 2.8125 = 10.8105$
5. $1.5937 \times 3.1875 = 5.0800$
6. $1.9687 \times 4.6875 = 9.2285$
7. $3.0000 \times 7.0000 = 21.0000$

Complete area = 15 square inches; sum of moments = 52.2527. Then

$$\frac{52.2527}{15} = 3.48,$$

or about 3½ inches from A to the center of gravity and neutral axis of the section.
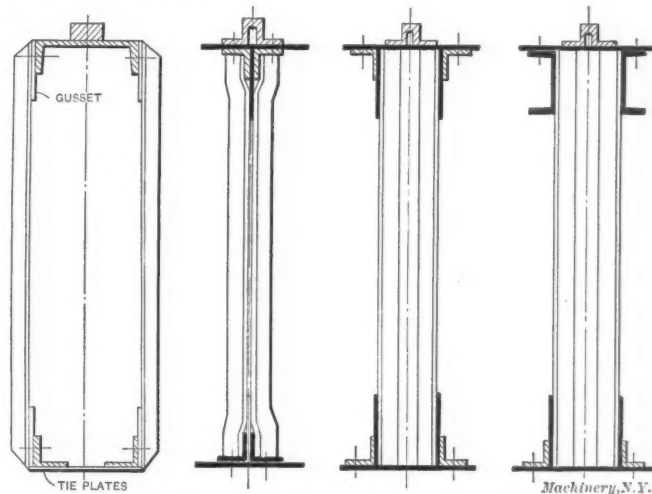
Figs. 38 to 41. Types of Girder Sections in Common Use

The next step is to find the moment of inertia of each half as divided by the neutral axis.

The moment of inertia of a section taken about its base is equivalent to $1/3\ b\,h^3$; therefore the moment of inertia of the section shown will be found as follows:

$1/3\ [\ (3.5^3 - 2.375^3) \times 2 + (2.375^3 - 1.25^3) \times 1 + (1.25^3 - 0.875^3) \times 3.25 + (0.875^3 - 0.5^3) \times 10.25 + (0.5^3 - 0.125^3) \times$

$4.625\ + (\frac{1}{8}^3 \times 1.125)\ ] = \dfrac{80.7}{3} = 26.9 =$ moment of inertia

of the upper half.

The moment of inertia of the lower part can be found in a similar manner, as follows:

$1/3\ [(7.5^3 \times 0.375) + (2.5^3 \times 0.75)] = 56.6 =$ moment of inertia of lower half.

Total moment of inertia of section = $26.9 + 56.6 = 83.5$.

This quantity, divided by the distance from the neutral axis to the upper or lower outer edge of the section, will give the compression and tension moduli, respectively, thus:

$$\frac{83.5}{3.5} = 23.8 = \text{compression modulus.}$$

$$\frac{83.5}{7.5} = 11.13 = \text{tension modulus.}$$

It is also necessary to know the maximum bending moment in the unsupported part of the top member, which, in the present case, occurs when one wheel of the crab is in the

center of the bay. It is difficult to say how much benefit is due to the fact that the unsupported parts of the top flange form a more or less continuous girder. The results due to taking the bending moment as being equal to $\dfrac{WL}{6}$ give satisfaction; the bending moment, in this case, is therefore equal to

$$\frac{5 \times 72}{6} = 60 \text{ inch-tons.}$$

The stress in the section from this load alone will be:

$$\frac{60}{23.8} = 2.5 \text{ tons per square inch, compression.}$$

$$\frac{60}{11.13} = 5.4 \text{ tons per square inch, tension.}$$

the values given in Table XII will be found useful. The safe loads given in this table are calculated by Gordon's formula. The factor of safety is five.

Generally speaking it is safe to consider that the struts have the ends fixed, in the plane of the rivets, but free in the opposite direction. Matters may be more nearly equalized between these two conditions if a small tie plate is used to tie the two sections forming one strut together. When, however, the work throughout is light, it is safer to take all struts as having free ends, and thereby avoid the possibility of flexure in different directions. A sufficient number of rivets should be allowed for at the joints to limit the stress to 5 tons per square inch in shear, and 8¾ tons per square inch of bearing.

Generally speaking, the last bay should be plated in, in order to stiffen the end joint and provide sufficient section to meet the shearing stresses.
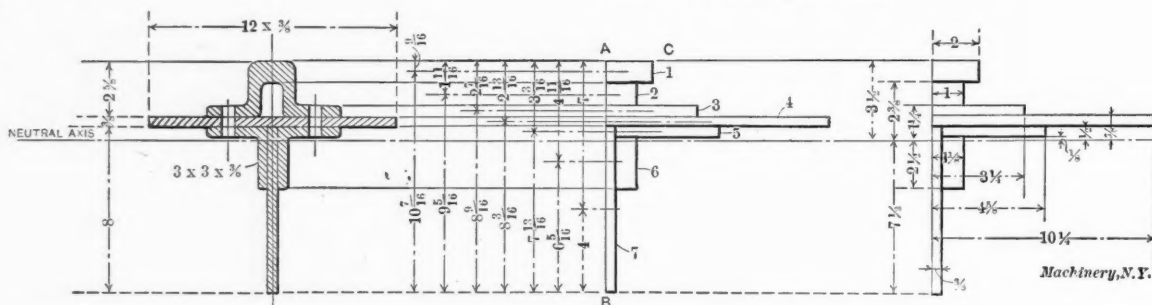
Figs. 42 and 43. Lay-out for Calculating Section Modulus of Girder Section

The maximum compression in the members from the load is equal to about 2.2 tons per square inch, and to this quantity the compression found above must be added, making the total maximum compression = 2.2 + 2.5 = 4.7 tons per square inch.

The above method is approximate and only suitable for the comparatively small girders used in crane work, and is not directly applicable to large bridge girders.

The stresses from bending alone should be kept as low as

It is seldom necessary to make any extra provision for shearing stresses at the various flange joints for small and medium sized girders, but for large girders these stresses should always be calculated and checked.

* * *

An interesting piece of apparatus employed by electricians is the "fish wire," used for threading insulated wire through pipes and other long narrow conduits. This fish wire is a finely tempered steel tape about 1/4 inch wide and 1/16 inch

TABLE XII. SAFE LOADS IN TONS FOR ANGLE IRONS WHEN USED AS STRUTS

F = fixed ends   R = round ends   Factor of safety = 5

Size of Angle, Inches	Safe Loads in Tons for Different Length of Strut													
	4 Feet		5 Feet		6 Feet		7 Feet		8 Feet		9 Feet		10 Feet	
	F	R	F	R	F	R	F	R	F	R	F	R	F	R
6 × 6 × ⅝	32.3	19.4	31.4	18.8	30.2	18.1	28.9	17.3	27.4	16.4	25.9	15.5	24.1	14.5
6 × 6 × ¾	38.3	23.0	37.2	22.3	35.8	21.5	34.2	20.5	32.5	19.5	30.6	18.4	28.5	17.1
5 × 5 × ½	21.1	12.7	20.2	12.1	19.1	11.5	17.9	10.7	16.5	9.9	15.1	9.1	13.6	8.2
5 × 5 × ⅝	26.0	15.6	24.9	14.9	23.5	14.1	22.1	13.3	20.4	12.2	18.6	11.2	16.8	10.1
4½ × 4½ × ½	18.5	11.1	17.4	10.4	16.3	9.8	15.0	9.0	13.4	8.0	12.0	7.2	10.6	6.4
4½ × 4½ × ⅝	22.7	13.6	21.5	12.9	20.1	12.1	18.4	11.1	16.6	10.0	14.7	8.8	13.1	7.9
4 × 4 × ½	15.8	9.5	14.7	8.8	13.4	8.0	12.0	7.2	10.6	6.4	9.2	5.5	8.1	4.8
4 × 4 × ⅝	19.4	11.6	18.1	10.9	16.6	10.0	14.7	8.2	13.0	7.8	11.3	6.8	9.9	5.9
3½ × 3½ × ⅜	10.2	6.1	9.2	5.5	8.2	4.9	7.1	4.3	6.1	3.7	5.2	3.1	....	....
3½ × 3½ × ½	13.3	8.0	12.1	7.3	10.6	6.4	9.2	5.5	7.9	4.7	6.8	4.1	....	....
3 × 3 × ⁵⁄₁₆	6.9	4.1	6.0	3.6	5.1	3.1	4.3	2.6	....	....	....	....	....	....
3 × 3 × ⅜	8.1	4.9	7.0	4.2	6.0	3.6	5.0	3.0	....	....	....	....	....	....
3 × 3 × ½	10.6	6.4	9.2	5.5	7.8	4.7	6.5	3.9	....	....	....	....	....	....
2½ × 2½ × ¼	4.1	2.5	3.4	2.1	2.6	1.6	....	....	....	....	....	....	....	....
2½ × 2½ × ⁵⁄₁₆	5.0	3.0	4.1	2.5	3.3	2.0	....	....	....	....	....	....	....	....
2½ × 2½ × ⅜	5.9	3.5	4.9	2.9	3.9	2.3	....	....	....	....	....	....	....	....

possible, in order to minimize the possibilities of deflection, which detracts from the value of the member as a strut. The safe working stress of this member, taken as a strut, pure and simple, and fixed in the plane of the joints, is generally taken as equal to about 4½ tons per square inch for a section having a radius of gyration of from 1/30 to 1/40 of the unsupported length. In fixing the size of the struts, some consideration should be given to the practical economy effected by using as few sections as possible, so that, although in the case of heavy cranes it is advisable to select sections to suit the varying stresses, it is better to select, say, two sections equal to the maximum stresses and use these throughout for girders of moderate size.

Angle sections are generally used both for diagonal and vertical struts, and in order to avoid continual calculations,

thick having slots in the ends for attachment to the wire that is to be pulled through. The fish wire is introduced into the pipe and pushed in as far as it will go by direct pushing. When it meets obstruction because of bends or the friction of the wire against the sides of the pipe, the workman then propels the wire along by pushing it in until the wire bends up, and then "snapping" it. A wave motion is transmitted along the wire or tape with the result that the far end jumps ahead a short distance. The operation is repeated indefinitely, and in this way long distances are threaded by the slender wire. It is even possible to guide the wire through a number of right angle bends, provided the elbows are of easy curvature. The secret of the process lies in taking advantage of the fact that wave motion can be produced by crumpling up the wire and snapping in that position.

EXPERIMENTS ON TWIST DRILLS—2

The following continuation of the article in the May number, gives the results of experiments conducted to obtain more accurate data for larger drills and heavier feeds. These experiments, briefly stated, are as follows:

(e) A series of experiments to determine the twisting moment or torque and end-thrust on twist drills of varying diameter when operating on soft cast iron with different rates of feed. No lubricant used. Termed ordinary trials.

(f) A set of experiments similar to the above when operating on Whitworth's medium hard (fluid-pressed) steel. No lubricant used. Termed ordinary trials.

(g) A set of trials on soft cast iron to determine the variation of torque and thrust with different cutting speeds. No lubricant used. Termed speed trials.

(h) Trials to determine the variation of thrust and torque on soft cast iron and medium hard steel with different diameter of drills and rate of feeds. An initial hole equal to the width of the chisel point was drilled in the specimen operated upon. No lubricant used. Termed minus-chisel-point trials.

mitted of a total speed variation to the drill of from 5 to 150 revolutions per minute. A counter fixed to the front of the machine and actuated from the spindle indicated the revolutions. The drill was held in the rotating spindle A, and could be advanced at varying rates, from 0.0025 to 0.050 inch per revolution, by suitable change wheels driven from the spindle sleeve and a square threaded cylinder on the end of the spindle. The work was supported on an angle plate bolted to the face-plate on the spindle in the tail-stock. This latter spindle, being free to slide, transmits the thrust on the drill to the diaphragm dynamometer fixed to the end of the spindle. The twisting force is taken by an arm bolted to the face-plate and having a knife edge on its further extremity which rests on a scale pan.

The driving gear B is keyed to the cast iron sleeve C which rotates within the bearings of the headstock D. A long key fitted at the end of the sleeve C, nearest to the work, drives the spindle A, while permitting it to slide longitudinally. The employment of a sleeve as a driver in this manner reduces the twist that would otherwise come on the spindle if it
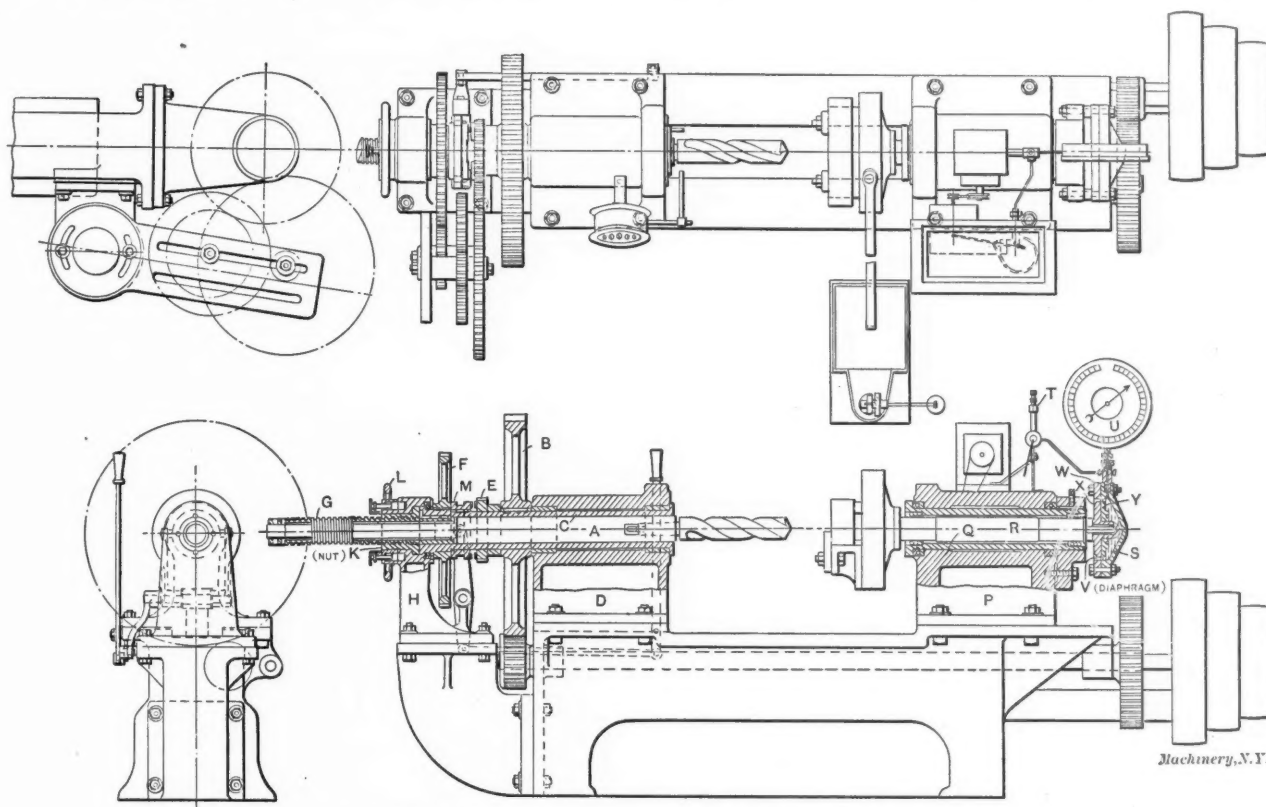

Fig. 2. Section and Elevation of Apparatus used in Second Set of Experiments

(i) A set of experiments to determine the variation of thrust and torque when operating on soft, medium and hard cast iron. No lubricant used. Termed hardness trials.

(j) A set of experiments similar to the above when operating on Whitworth soft, medium and hard (fluid-pressed) steel. No lubricant used. Termed hardness trials.

(k) A set of trials similar to (j) but with a lubricant of oil and water. Termed lubricated trials.

(l) A set of trials to find the effect produced by varying the point angle when operating on soft cast iron. No lubricant used. Termed point angle trials.

(m) A set similar to (l) when operating on soft (fluid-pressed) steel and lubricated with a mixture of water and oil. Termed point angle trials.

Description of Second Apparatus

The experiments (e) to (m) were carried out on a horizontal milling machine which had been reconstructed and modified. The arrangement is shown in detail in Fig. 2, and by the half-tone in Fig. 4. The power was obtained from a motor which drove a countershaft whereon was mounted a three-stepped cone pulley similar to that on the machine. Two pairs of wheels were introduced between the cone and the driving spindle, but one pair could be suppressed to allow of an increased speed to the spindle. The arrangement per-

were driven from the gear B direct. It also divides the wear due to rotation and sliding. As the wear due to the former is greatest, adjustment for the same is provided. It is clear that if the spindle is allowed any freedom it will wobble, thereby enlarging the hole and in all likelihood breaking the drill. The feed to the drill is secured through the pinion E, mounted freely on the sleeve C, which engages the train of gears on the quadrant, bolted to the bed, and the gear F keyed to the threaded cylinder G. The gear F is held in bracket H by an annular plate, while immediately ahead of it is a nut K which embraces the screw G and is held to the bracket by pins through the hand-wheel L. The cylinder G rotates independently of the spindle and is prevented from moving longitudinally thereon by a shoulder at one end and lock-nuts at the other. Friction washers are introduced between these members to take the wear. Thus, on the engagement of the clutch M (which is keyed to C) with the pinion E, a definite horizontal movement is given to the spindle per revolution of the same. The hand-wheel L is keyed to K and furnishes a quick withdrawing motion to the drill, on the locking pins being withdrawn.

The torque on the drill is obtained by multiplying the load on the scale pan (after the initial load due to the weight of the arm and unbalanced weight on the face-plate has been

subtracted) by the length of the arm measured from the center of the hole to the knife edge.

Balls have been fitted in pockets of the cast iron sleeve Q to allow the spindle R to slide longitudinally with the minimum of frictional resistance. The hydraulic support to take the end-thrust of the drill consists of a phosphor bronze casing S, fitted with a filling plug T and a standard pressure gage U. The diaphragm V is of cold drawn brass 0.010 inch thick. It is held to the casing by bolts and a steel ring W. The thrust pad X is provided with a cup-shaped recess to receive the spherical end of the spindle R. The pad is made fast to V by the nut Y within the casing. The end-thrust on the drill deflects the diaphragm at that part which is free (about ⅛ inch) between S and X, thereby producing a pressure in the fluid which is shown on the gage. The fluid in this case is water. A small filling plug is fitted in the end of the gage tube to allow any air to escape in order that the diaphragm deflection may be as small as possible. When the fluid is air-free, the diaphragm will only yield by the amount
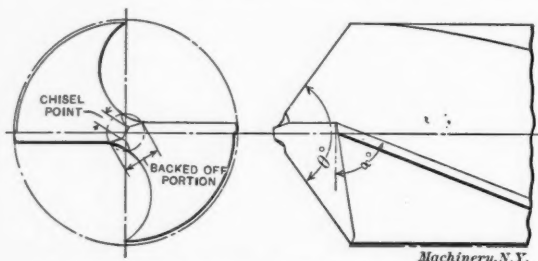
Fig. 3. Form of Point of Drill used in Experiments

necessary to supply the increased volume of the gage tube due to the added pressure. The spring of the tube is sufficient to bring the diaphragm back to its original position when the load is removed.

The shape of the point of a 3-inch drill used in the experiments is shown in Fig. 3. The width of the chisel point (or thinned down web) is approximately 0.096 d, and the width of the backed-off portion 0.168 d. The average cutting angle at right angles to the lip at the periphery is 68 deg. 48 min.

Results of Second Set of Experiments

Experiments (e) showed that the torque does not increase as fast as the feed for any given diameter of drill. The formula below closely agrees with the results obtained for all sizes of drills and all feeds:

$$T = 785\ d^{1.82}\ t^{0.72 - 0.0065d} \qquad (20)$$

The coefficient and exponents of the right-hand term in the formula above may be modified, and the error in the simplified formula

$$T = 740\ d^{1.8}\ t^{0.7} \qquad (21)$$

is inappreciable. A safe approximation without fractional exponents may be given in the form

$$T = 10\ d^2 + (14d^2 + 3)\ 100\ t \qquad (22)$$

As the drill entered the specimen, the torque gradually increased, and the torque at starting at no time exceeded the value obtained when drilling the full diameter hole. The torque increases almost in proportion to the square of the diameter of the drill, for any given feed.

The cutting pressure f, in tons per square inch, is found from the formula

$$f = \frac{35.4}{d^{0.2}\ t^{0.3}} \qquad (27)$$

It is clear from the above equation that the cutting pressure per square inch decreases with an increased diameter and also with increased feed. The cutting pressure, which is exerted along the radial cutting edges and resists rotation, should not be confused with the end thrust which is exerted in the direction of the axis of the drill.

Experiments for Determining the End Thrust

The following formulas, of which the latter is an approximation of the former, express the results obtained in the experiments for the determining of the end thrust when drilling soft cast iron:

$$P = (d - 0.4)\ 325 + (24\ d + 65)\ 1,000\ t, \qquad (28)$$
$$P = 240\ d + (24\ d + 65)\ 1,000\ t, \qquad (28a)$$

For ordinary feeds the following approximation is fairly correct:

$$P = 200\ d + 10,000\ t, \qquad (28b)$$

The end thrust can also be expressed by an equation of the form:

$$P = 35,500\ d^{0.7}\ t^{0.75} \qquad (30)$$

At no time did the force required for starting the drill exceed that when the drill was cutting a full diameter hole, and the first sets of experiments were thus confirmed. In this, the results of the experiments differ from those given by Prof. Breckenridge; the results also differ from those obtained by Messrs. Bird and Fairfield, who found that the thrust increased much faster than the feed. The results obtained by Messrs. Bird and Fairfield may possibly be accounted for by the high-speed at which they ran the drill, which produced a bluntness affecting the thrust more than the torque. In the trials at the Manchester School of Technology the speed was kept at 10 revolutions per minute in order that the blunting would not affect the results.

Experiments on Medium Hard Steel

The experiments (f) on medium hard steel showed much regularity. The torque was found to increase in a slower proportion than the feed, and it was also found that the torque did not increase as the square of the diameters of the drills, but in a smaller ratio, so that as far as the torque is concerned, the most economical way to remove metal is to use a coarse feed and a large diameter drill. A fairly simple, although approximate expression for the torque when drilling medium hard steel is:

$$T = 28\ d^2\ (1 + 100\ t), \qquad (32)$$

Another approximation may be expressed by the formula:

$$T = 1,640\ d^{1.8}\ t^{0.7}$$

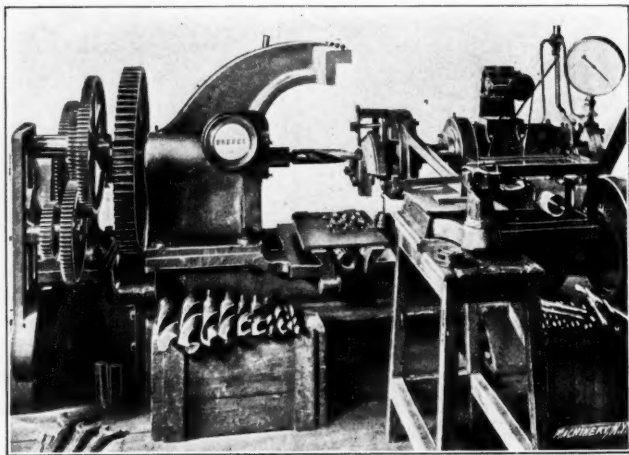which is fairly correct for all feeds in common use.

Fig. 4. Apparatus used in the Manchester Drill Experiments

For the end thrust the two following formulas are given, which are fairly simple in their form, but which, however, are only approximations which are correct for the range of feeds ordinarily used in practice. The latter formula, however, closely agrees with the rather complicated exact equation which was obtained from the experiments. While no experiments were undertaken at this time with blunt drills, it was noticed during the trials that the thrust may increase as much as 20 per cent by the dulling of the chisel point alone. This, of course, indicates that for ordinary shop practice it is useless to insist on anything but the approximate formulas.

$$P = 750\ d\ (1 + 150\ t), \qquad (35)$$
$$P = 35,500\ d^{0.7}\ t^{0.6}$$

Variations of Cutting Stress with Cutting Speed

In experiments (g), the speed, instead of remaining constant at 10 revolutions per minute was varied from 7.5 to 126 revolutions, with the object of determining the variation of thrust and torque due to speed. There did not seem to be any marked difference due to the speed, and in this particular, these experiments, therefore, confirm those made by Messrs. Bird and Fairfield.

The experiments show that metal is most economically removed by increasing the feed or diameter of drill rather than

the speed, since the power in the latter case is directly proportional to the speed. The friction horse-power of the machine is practically proportional to the speed, so that if the speed is doubled the power is also doubled. When, on the other hand, the feed is doubled, the frictional horse-power remains about the same. By increasing the number of lips to three or more, the torque and the thrust are increased for any given feed as the feed actually taken by each lip is $\frac{1}{n}$ of the whole feed, where n is the number of lips.

Tables I and II have been calculated from the above results for the speed and feed recommended by drill makers for

TABLE I. REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE, AND HORSE-POWER WHEN DRILLING CAST-IRON WITH HIGH-SPEED STEEL DRILLS

1	2	3	4	5	6	7	8
Diameter of Drill in Inches	Revolutions per Minute $N = \frac{12 \times 48}{\pi d}$	Feed in Inches per Revolution of Drill $t = \frac{d^{\frac{1}{2}}}{84}$	Cubic Inches removed per Minute $1.715\, d^{\frac{3}{2}}$	Cutting Horse-power $1.16\, d$	Feeding Horse-power $\frac{d^{\frac{5}{2}}}{142}$	Total Horse-power	Horse-power per Cubic Inch of Metal removed per Minute
0.25	735	0.0075	0.27	0.29	0.005	0.295	1.092
0.375	490	0.0086	0.462	0.435	0.0055	0.4405	0.954
0.5	368	0.0094	0.682	0.58	0.0059	0.586	0.862
0.75	245	0.0109	1.17	0.87	0.0066	0.8766	0.748
1.0	184	0.0119	1.715	1.16	0.007	1.167	0.681
1.25	147	0.0129	2.32	1.45	0.0073	1.457	0.628
1.5	122	0.0136	2.92	1.74	0.0078	1.748	0.598
1.75	105	0.0144	3.63	2.03	0.0081	2.038	0.563
2.0	92	0.0150	4.32	2.32	0.0084	2.328	0.539
2.25	81.7	0.0156	5.05	2.61	0.0086	2.619	0.519
2.5	73.5	0.0162	5.82	2.9	0.0089	2.909	0.500
2.75	66.75	0.0167	6.6	3.19	0.0091	3.199	0.486
3.0	61.3	0.0172	7.4	3.48	0.0093	3.489	0.472
3.25	56.5	0.0176	8.22	3.77	0.0095	3.78	0.46
3.5	52.5	0.0181	9.05	4.06	0.0096	4.07	0.45
3.75	49	0.0185	10.0	4.35	0.0098	4.36	0.436
4.0	46	0.0190	10.8	4.64	0.00995	4.65	0.431

ordinary shop use. There is no general agreement among the makers of high-speed twist-drills as to what the cutting speed should be for ordinary shop practice. Some decrease the speed with the increase of diameter of drill, some recommend the reverse, but most makers advise a constant periphery speed throughout. The mean of these values is about 60 feet per minute with a feed per revolution of $\frac{d^{\frac{1}{2}}}{100}$ for machine steel. For cast iron it is usual to decrease the above speed 20 per cent and increase the feed by a similar amount. Using these figures and the experimental force values previously given, an estimate of the net horse-power required for drilling can be made. With the object of presenting these results in concise form and to show at a glance the influences of speed, feed and diameter, the values so deduced have been tabulated in Tables I and II.

The cubic inches of metal removed per minute (V) is found approximately from the equation:

$$V = \frac{\pi}{4}\, d^2\, t\, N,$$

where $N =$ revolutions per minute.

The cutting horse-power is obtained by multiplying the torque for each feed and diameter of drill by $\frac{2\,\pi\,N}{33,000}$.

$$\text{Cutting horse-power} = \frac{2\,\pi\,N\,T}{33,000}.$$

The horse-power required for feeding is obtained by multiplying the end thrust for each feed and diameter of drill by $\frac{t\,N}{33,000}$.

$$\text{Feed horse-power} = \frac{P\,t\,N}{33,000}$$

Minus-chisel-point Experiments (h) on Soft Cast-iron and Medium Steel

These experiments were undertaken with the object of determining the difference in the thrust and torque due to the chisel point of the drill. Many efforts were made at the outset to drill a hole with a chisel shaped and ground similar to that on the drill itself. Frequent breakages, particularly when operating on steel, led to the abandonment of this procedure in favor of that where a hole was initially made in the specimen, having a diameter equal to the width of the chisel point of the drill to be employed. The tests were then made with different feeds and diameters of drills at a speed of 10 revolutions per minute as in the ordinary trials previously discussed.

It was found that the torque in these experiments was practically the same as the torque obtained in the regular experiments. Of course, the torque in the minus-chisel-point trials should be smaller, but the difference is so insignificant as to be lost sight of in the approximate formulas adopted. Considerable difference, however, is found in regard to the end thrust when a piece is removed in the specimen equal to the diameter of the chisel point. Thus, for cast iron, the end thrust

$$P = 12,600\, d^{0.7}\, t^{0.6} \tag{39}$$

Comparing this equation with those just obtained in the ordinary trials (e), it will be seen that twenty-five per cent of the end force for feeds commonly required, is due to the chisel point.

The end thrust for medium steel in the minus-chisel-point trials was

$$P = 27,000\, d^{0.73}\, t^{0.6} \tag{40}$$

TABLE II. REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE, AND HORSE-POWER WHEN DRILLING MEDIUM HARD STEEL WITH HIGH-SPEED STEEL DRILLS

1	2	3	4	5	6	7	8
Diameter of Drill, in Inches	Revolutions per Minute $N = \frac{12 \times 60}{\pi d}$	Feed in Inches per Revolution $t = \frac{d^{\frac{1}{2}}}{100}$	Cubic Inches removed per Minute $1.8\, d^{\frac{3}{2}}$	Cutting Horse-power $2.85\, d$	Feeding Horse-power $\frac{d^{\frac{5}{2}}}{77}$	Total Horse-power	Horse-power per Cubic Inch of Metal removed per Minute
0.25	920	0.0063	0.284	0.712	0.0092	0.721	2.54
0.375	614	0.0072	0.485	1.068	0.0102	1.078	2.22
0.5	460	0.00795	0.716	1.425	0.0109	1.426	1.99
0.75	306	0.0091	1.23	2.14	0.0121	2.152	1.75
1.0	230	0.01	1.8	2.85	0.013	2.863	1.59
1.25	184	0.0108	2.44	3.56	0.0138	3.574	1.47
1.5	153	0.0114	3.08	4.27	0.0145	4.285	1.39
1.75	131	0.0121	3.81	4.99	0.015	5.005	1.31
2.0	115	0.0126	4.54	5.7	0.0155	5.715	1.26
2.25	102	0.0131	5.3	6.42	0.0159	6.436	1.21
2.5	92	0.0136	6.12	7.12	0.0163	7.136	1.165
2.75	83.5	0.014	6.92	7.84	0.0167	7.857	1.135
3.0	76.5	0.0144	7.76	8.55	0.0171	8.567	1.105
3.25	70.5	0.0148	8.66	9.25	0.0175	9.267	1.07
3.5	65.6	0.0151	9.5	9.98	0.0178	9.998	1.05
3.75	61.25	0.0155	10.48	10.7	0.0181	10.718	1.024
4.0	57.5	0.0158	11.4	11.4	0.0184	11.42	1.0

which is about twenty-one per cent less than the end thrust in the regular trials.

Results of Experiments Undertaken on Different Kinds of Metal

The experiments on the variation of torque and thrust when drilling different grades of cast iron showed that the torque and thrust increased very rapidly with the percentage of carbon.

The experiments on the variation of torque and thrust when drilling steel of different kinds without and with lubricant, showed that there is little difference between the torque and thrust for soft and medium steels when not lubricated. This, no doubt, is due to the high percentage of manganese in the soft steel. Roughly speaking, the torque and thrust are practically proportional to the combined carbon and manganese contents for any given feed. In the lubrication tests, it was found that the percentage of decrease in the torque

due to lubrication was almost the same in soft and hard steel, and that this decrease is most conspicuous in the finer feeds. The average torque for each feed in these trials varies from 72 per cent with the 0.0025 inch feed to 92 per cent with the 0.0285 inch feed of that obtained when operating dry.

The thrust for soft, medium and hard steel is 26 per cent, 37 per cent and 12 per cent, respectively, less than that obtained when operating dry.

Variation of Torque and Thrust with Angle of Drill Point

The experiments for determining the torque and thrust due to different point angles were carried out with three drills having 90, 120 and 150 degrees included point angle, respectively. These experiments indicate that the torque decreases as the included angle becomes larger, but the end thrust increases. It will thus be noted that while the 90-degree included angle drill has a smaller end thrust, the torque is larger, and the 150-degree included angle drill has a larger end thrust but a smaller torque. Two distinct opposite effects enter in the determining of the correct angle, and the experiments were insufficient to assign a value to each of these effects; but it may be assumed that the commonly accepted angle of 118 degrees included angle is the most advantageous to use, as here both the torque and the end thrust have average value.

Conclusions of First Set of Experiments

(a) The horse-power for a given diameter of drill and feed is proportional to the revolutions or the cutting speed.

(b) The horse-power $\dfrac{2 \pi N T}{33,000}$ is proportional to the torque, and for a given drill and speed does not increase as fast as the feed.

(c) Since the torque is practically proportional to the square of the diameter of the drill, the horse-power, for a given feed and cutting speed, is directly proportional to the diameter of the drill.

(d) The horse-power per cubic inch of metal removed is inversely proportional to the feed and independent of the drill and cutting speed.

(e) The work required to drill a given hole, when one drill only is used, is greater than that required to drill the same hole in two operations with drills of different diameters. The greater the difference in the drill diameters, the greater the saving in work, speed and feed remaining the same throughout. This is due to the fact that the mean cutting angle of the single drill is greater than the average angle in use for the two drills and that the stress is proportional to the angle.

(f) With twist-drills having the usual proportions, the cutting angle is not sufficiently keen to drag the drill into the work when enlarging a hole in cast iron or steel.

Conclusions of Second Set of Experiments

(g) The horse-power when operating on soft cast iron or medium steel varies as $t^{0.7}$ for a given drill and speed; ($t =$ feed per revolution).

(h) The horse-power for a given feed and speed does not increase as fast as the diameter but varies as $d^{0.8}$; ($d =$ diameter of drill).

(i) The torque and horse-power when drilling medium steel is about 2.1 times that required to drill soft cast iron with the same drill speed and feed.

(j) The horse-power per cubic inch of metal removed is inversely proportional to $d^{0.2} t^{0.3}$ and independent of the revolutions.

If d remains constant, and feeds of 0.0025 inch, 0.010 inch and 0.040 inch be taken, the corresponding horse-powers will be in the order of 1, 0.66 and 0.435. If t remains constant and values of $d = \frac{1}{2}$ inch, 2 inch and 4 inches be taken, then the horse-power for each successive drill will be in the order of 1, 0.76 and 0.66.

(k) The power required to enlarge a hole may be estimated from the pressures given by equation $f = \dfrac{0.44}{t^{0.33}} \times$ cutting angle in degrees, for cast iron, and 2.1 times that value for medium steel.

(l) In a two-lipped drill the actual depth of cut taken by each lip is $\dfrac{t}{2}$; in a three-lipped drill, $\dfrac{t}{3}$; and so on.

If the number of lips is increased, and t kept the same the pressure produced is equivalent to that for a proportionately decreased feed. If the lips are unequally ground, so that one lip does all the work, the cutting pressure is the same as that obtained by doubling the feed. By gashing the lips of the drill in such a manner that the cut taken by one lip is the metal left by the other, the pressure is the same as that given for twice the feed.

The finer the feed the greater the cutting pressure, and consequently the greater the power required per cubic inch of metal removed.

(m) The end-thrust when operating on cast iron or steel does not increase in *proportion* to the feed for a given diameter of drill or in proportion to the diameter for a given feed.

(n) While the chisel point scarcely affects the torque, it is accountable for about 20 per cent of the end-thrust.

(o) The lubricated trials on steel when compared with the dry tests show a diminution in the torque and horse-power, varying from 28 per cent with the 0.0025 inch feed to 8 per cent with the 0.0285 inch feed. This may be due to the lubricant washing away the small metal chips which tend to jam between the walls of the hole and the drill, and to the preserved cutting edge. The end-thrust is reduced by about 25 per cent for all feeds.

(p) The drill most commonly adopted in practice has an included angle at the point of 120 degrees. [United States, 118 degrees.—EDITOR.] If this angle is increased the torque diminishes, but the end-thrust increases, while if this angle is decreased, the reverse is the result. So far as economy in power is concerned the torque is the factor to consider, as the feeding horse-power is only about 1 per cent of the whole in small drills and very much less for the larger sizes. From this point of view the drill with the larger point angle is to be preferred. The accompanying increased end-thrust, however, strains the machine parts in proportion. When the point of the drill breaks through the metal at the bottom of the hole, a considerable portion of the end load is removed. The strain due to that load is released, thereby causing the drill to advance more than its rated feed and possibly break the drill. The drill with the greater included angle will be most likely to give trouble in this direction, both on account of the increased strain and torque.

(q) By decreasing the spiral of the drill a keener cutting angle with a decreased end-thrust and torque can be obtained without altering the point angle above the accepted standard. This, however, would in turn affect the durability of the drill.

(r) With a small included point angle there is little metal to support the cutting edge at the chisel point, and trouble due to blunting of this part is to be expected.

(s) In estimating the time required to drill a hole of given depth the length of the drill point must be taken into account. The length of the point for different included point angles is:

for 90 degrees $= 0.5\ d$.
for 120 degrees $= 0.29\ d$.
for 150 degrees $= 0.134\ d$.

* * *

A correspondent, in a recent letter commenting on the reluctance of some good mechanics to subscribe to a journal devoted to their business, mentions a case illustrating the ignorance of a round-house foreman who prided himself on being well-informed. This man came to the writer one day much excited over the wonderful exhibit of a new apparatus which with a tiny flame enabled the operator to either weld or cut steel with rapidity. With it, the foreman said, he would be able to cut a piece of high-speed steel in two, and weld it together again if it were required, and so on at length. The writer, after some questioning, discovered that the apparatus was the oxy-acetylene torch used for autogenous welding and cutting, the work of which has been described several times in MACHINERY. Had the foreman been a reader of technical journals, he would not have displayed his ignorance of an apparatus that has practically demonstrated its value and which already is being used to a considerable extent for repair work, etc.

MACHINES AND TOOLS FOR AUTOMOBILE MANUFACTURE*

C. B. OWEN†

Upon first thought the design and construction of tools and jigs for automobile manufacture may not appear to present any problems radically different from those involved in the manufacture of any other power producing and transmitting machinery; but after a thorough consideration of the conditions under which a motor car necessarily operates, the importance of a standardized, in t e r changeable, simple and strong construction is

C. B. Owen‡

realized. As one of the requirements of a car is maximum power with minimum weight, the use of nickel and other steel alloys is required, which, in turn, necessitates the use of high-speed steel in the machine tools. As an automobile engine is necessarily a high-speed engine,

most likely to occur, the advantages of interchangeable construction, the parts of which are so designed that they can *not* be incorrectly assembled, are apparent, especially when road repairs must be made by men not thoroughly familiar with the construction of all cars. These are facts that the motor car designer must have seriously in mind, and which must reflect themselves to some extent in the tool design.

It is the purpose of this article to show how these ideas are carried out in practice, in the factory of the Cadillac Motor Car Company, Detroit, Michigan, and, while space permits showing only a few of the several thousand special tools, jigs and fixtures, it is thought that those shown will illustrate the care taken to secure absolute interchangeability and perfect alignment of parts. As the construction of the motor includes some very interesting tools, these together with some testing jigs are shown and described.

Engine Frames

As the engine frame is in two parts, divided horizontally at the shaft center, accurate milling and drilling is required. Heavy Brown & Sharpe, Cincinnati, and Leland & Faulconer machines fitted with heavy jigs and large inserted tooth cutters are used on this work. Fig. 1 illustrates the L. & F.
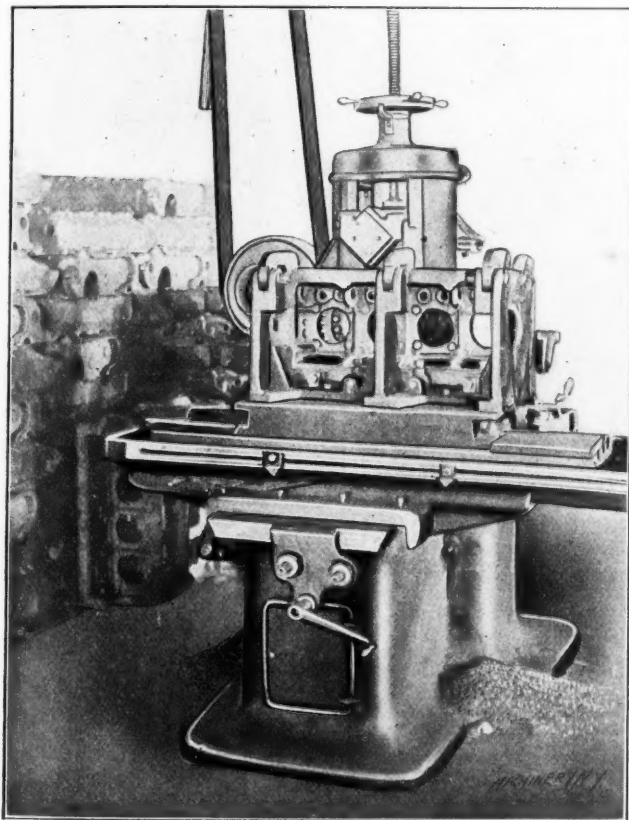
Fig. 1. Milling Engine Frames

Fig. 2. Machine for Boring Frames

the provisions for adjustment of wearing parts and the cheap replacement of them when worn out, are of primary importance.

As the great majority of automobile owners are not mechanically inclined and wish the greatest amount of service with the least possible attention to their cars, the necessity of simple and reliable construction is apparent; and, as the motor car is forced by road conditions to do its hardest work on the poorest roads (which are usually farthest from the best repair facilities), under which conditions breakages are

machine milling the top face of the engine frame where the cylinders bolt on. This machine is very satisfactory for manufacturing, as the low table permits rapid handling of work, and its heavy construction, large bearing surfaces and all geared feeds and speeds provide for heavy and rapid cutting. The teeth of the cutter are seen through the openings in the work.

Fig. 2 shows the method of boring the seats for the cylinders in the engine frame. This operation follows that shown in Fig. 1. The cutter heads have a floating drive and are centered by the ground pilots entering inserted bushings in the jig bosses. The whole jig slides forward and back against a stop to facilitate inserting and removing the work.

Fig. 3 shows the lower half of the crank-case (shown in Fig. 7 of the article on "Organization and Equipment of an Automobile Factory in MACHINERY for March, 1909) clamped in the jig for drilling 24 holes for studs and cap-screws. The 24 spindle Baush machine drills these holes in about two minutes, including inserting and removing the work. A similar style of jig is provided for the upper half of the crank-case, which has 18 holes to be drilled in the lower face.

Fig. 5 shows the jig provided for boring the cam-shaft bearing seats in the upper half of the crank-case. These seats are indicated by the letter A, and are a very close fit for the five bronze bearings which carry the cam-shaft. The work locates over the two large bosses in the center of the jig, and rests on hardened and ground plugs inserted in the base. The swing clamps shown bear directly over the plugs. The boring tool, which is driven by a face-plate fixture, is seen projecting through one of the guides. The B. & S. plug gage seen on the

degrees from others, the reaming jig is designed with a view to extreme accuracy. In operation the first hole reamed is the one by which the drive gear (Fig. 3, March issue) is pinned on. The taper reamer is guided by the bushing in the clamping fixture at the right, and the collars are so adjusted as to ream the hole to the required size. The shaft is then slipped through the square, hardened-and-ground steel block seen at the left in the illustration, and a master pin is inserted. The block is then slipped along in the frame
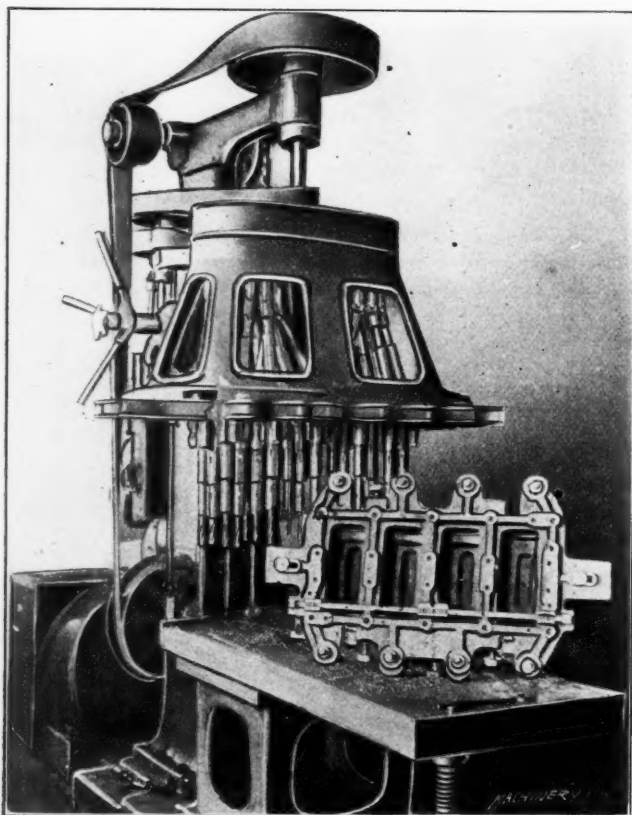
Fig. 3. Twenty-four-spindle Machine for Drilling the Frames

Fig. 4. Bevel-gear Milling Machine of the Templet Type

lathe carriage, allows only 0.002-inch variation in the size of the holes. A similar type of jig (not shown) is used for boring the main bearing seats in the lower half of the crank-case, and an adjustable hand reamer with a very long pilot

of the jig and clamped by the screws seen on top of the fixture as the various holes come under the reamer. The projecting block seen at the extreme right end of the jig, forms a rest for the cam-shaft as it is passed along. As the taper holes
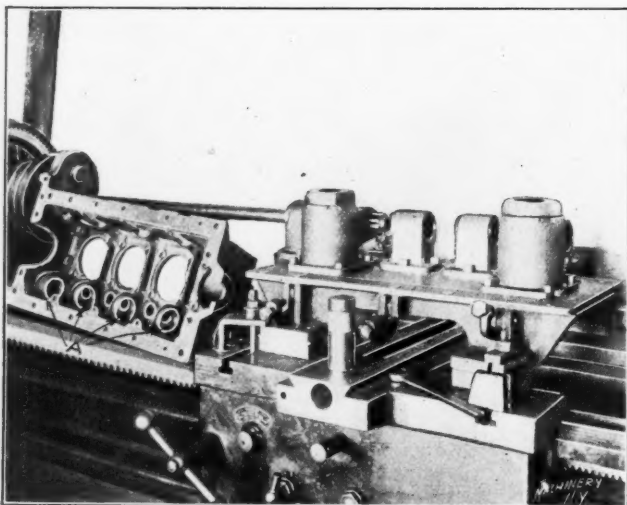
Fig. 5. Fixture for Boring Cam-shaft Bearings in Engine Frame

Fig. 6. Fixtures for Drilling and Reaming Cam-shafts

is used for finishing them. The variation in size allowed on the bearing bushings is only 0.0015 inch and only 0.001 inch on the shaft bearings.

Cam-shaft

Fig. 6 shows both the cam-shaft drilling and reaming jigs on the same machine table, for convenience. The drill jig (seen in front) is of steel with hardened bushings with an adjustable stop-screw in the end. This jig gives the correct position of the holes for the eight cams and the drive gears. As the holes are to be reamed in pairs and each pair is 90
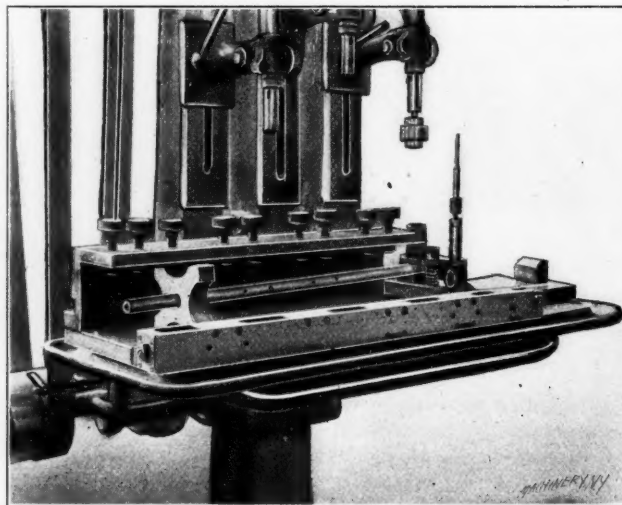
in the cam-shaft, cams and cam-gears, must bear the correct relation to each other, a set of master pins is provided for testing the depth of the reaming. These are hardened and ground tool-steel pins having two fine lines 0.020 inch apart around them at the point where they project through the hole in either the shaft, the cam or the gear. As a variation of 0.001 inch in the diameter of a standard taper pin hole permits the pin to enter 0.040 inch deeper into the hole, the accuracy of this work can be realized when it is known that no hand reaming is required in assembling the cam shaft. The

cams are drilled and reamed in similar jigs, which, in all cases, locate the cams by the eccentric portions. The inlet cams are alike and interchangeable, as are also the exhaust cams. The cams are of selected steel, properly hardened and finished by grinding the working surfaces in the correct relation to the pin holes.

Cylinders

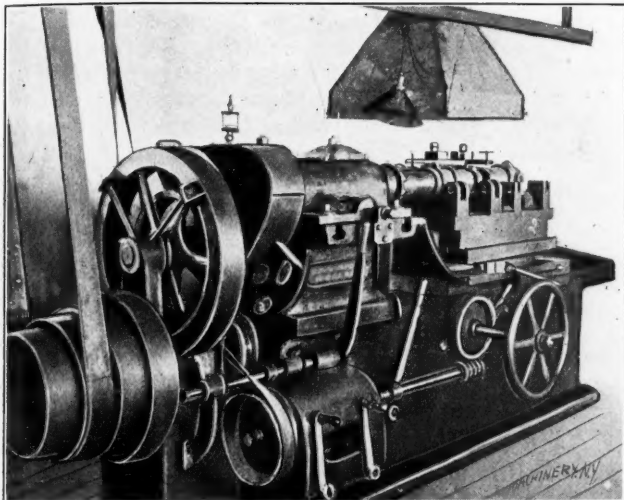Fig. 7 illustrates the method of boring the cylinders in a double spindle Beaman & Smith machine, with a turn-table

Fig. 7. Boring Cylinders

fixture whereby two cylinders may be changed while two others are being bored. As the cylinder castings are very uniform in size, the boring leaves the walls very uniform in thickness. After being bored and reamed the cylinders pass to the testing bench where water pressure of 700 to 800 pounds per square inch is applied to test them for leakage. Those passing the test are taken to the screw machine department and put on an expanding arbor in a large Potter & Johnston
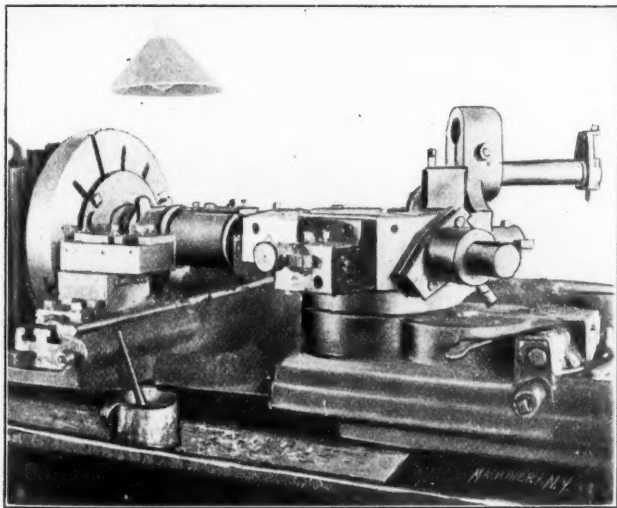
Fig. 8. Turning Cylinders

machine for facing and tapping the top and turning the portion of the cylinder which enters into the crank-case of the motor. The machine and tools for these operations are seen in Fig. 8. The turret tools in the foreground are those used in roughing off and boring the upper end of the cylinder for the cylinder head nipple. The heavy overhanging turret tool finishes the flange on the cylinder for the copper water jacket. The rear cross slide carries the tools for roughing this flange and also the flanges through which the studs pass for fastening the cylinders to the engine frame, while the forward cross-slide tools finish the stud flanges and a portion of the cylinder where it enters the bored seat in the engine frame.

The cylinders are finished by grinding in Brown & Sharpe and Heald machines. A heavy angle-plate fixture, bored and faced to a very close fit on the cylinder diameter, is fitted to the table of the machine as shown in Fig. 9. The cylinder is clamped to this fixture exactly as it is held later in the

assembled motor. Cooling water is supplied to the outside of the cylinder, and the air tube seen at the extreme right conveys the particles of metal and emery to a suction fan at the rear of the machine. The "Go" plug gage seen on the machine table, is 4 inches in diameter and the "Not Go" gage is 4.002 inches in diameter.

Pistons and Rings

The second operation of roughing off the pistons in a Gridley automatic turret lathe is shown in Fig. 10. The first operation is not shown, as it consists only in chucking and roughing off the outer diameter of the head end for about an inch to permit the steadying roll passing over the end. The upper roll has but slight travel, as it forms a part of the end facing tool. The heavy turning tool is carried in the rear tool-holder, which also carries another roller; this roller supports the piston against the side thrust on it, caused in cutting the ring grooves. The view shows the very heavy character of the tools, and the provisions for adjustment. The
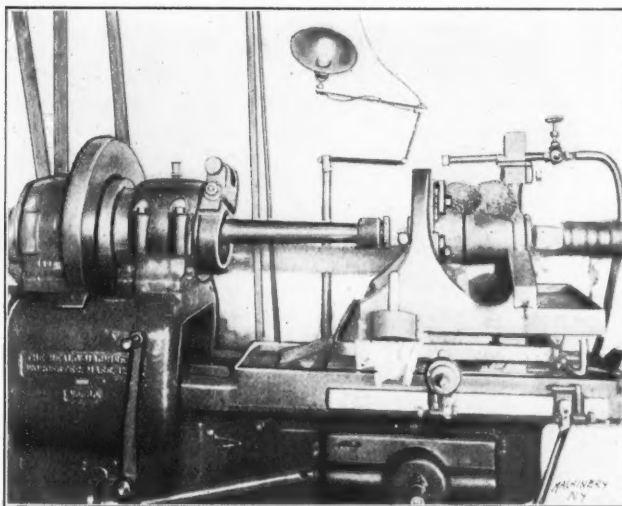

Fig. 9. Grinding Cylinders

piston is held by an internal draw-in fixture, thus permitting the turning tool to travel its entire length. (An illustration and description of a similar fixture will be found in the article "Automobile Engine Building in a Steam Engine Plant" which was published in the April, 1907, issue of MACHINERY.) The finish is by grinding in heavy Brown & Sharpe and Norton machines, as illustrated in Fig. 11. The greatest vari-
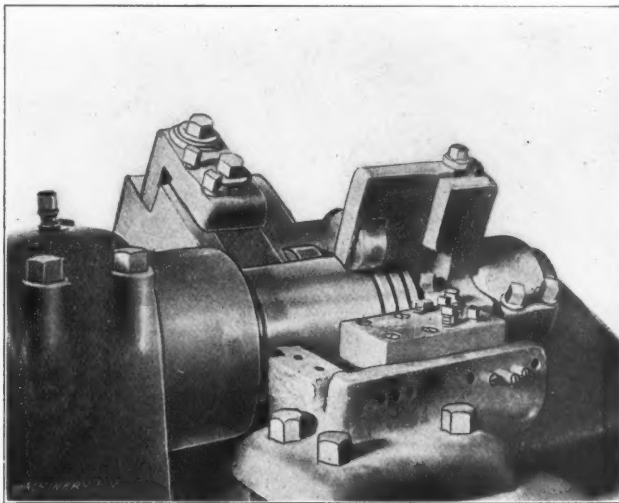

Fig. 10. Turning Pistons

ation in size permitted is 0.002 inch. A finishing cut is taken from the open end of the piston in a special reaming fixture just before grinding, which prevents any possible distortion of the piston due to changes in the metal after the open end has been machined. The piston pin hole is bored in box jigs and 0.001 inch is left for hand reaming previous to assembling the piston and connecting-rod. A final light finishing cut is taken from the piston ring grooves after the piston is ground.

The piston rings are of a special close-grained iron mixture, and are turned and bored on Gridley machines, and finished

by grinding. The ring joint is the standard 45-degree angle joint, which has always given good results in practice.

Connecting Rods

The connecting-rods are drop forgings of H-section, having a pressed-in bronze bushing bearing for the piston-pin, and a hinged cap carrying babbitt-lined bronze half-bushing bearings for the crank-pins. While the machining of the rods requires a set of very complete and accurate jigs and tools, limited space prevents their illustration. Two of the fixtures for testing the alignment of the assembled rods, however are shown in Figs. 13 and 14. Fig. 13 shows the method of locating the piston-pin bushing central with the crank-pin bearing, which is held in the hinged end of the rod by large brass dowels. A plug is placed between the half bearings, and the adjusting screw tightened down sufficiently to hold them tightly in place. The piston-pin bushing having been pressed in approximately central and hand reamed, is then slipped on the ground arbor which is pressed into the casting and positively held by a large hexagon nut. The knurled nut A is then screwed on the outer end of the arbor, thus holding the piston-pin bushing against a ground shoulder on the fixed arbor. The micrometer screw is then brought up until it touches the edge of the crank-pin bearing, a reading taken, and the screw backed away. The nut A is then loosened, the connecting-rod slipped off, turned over and replaced on the arbor and another reading of the micrometer screw is taken. The difference in the two readings thus indicates the amount the two bearings are out of line with each other. For overcoming this variation, the two knurled nuts B and C are provided. Nut B is internally threaded to fit a threaded portion of nut A, and in use screws up against the face of the connecting-rod forging for pressing it farther on the bronze bushing. Nut C which is internally threaded to fit a portion of the fixed arbor, operates to move the rod forging in the opposite direction. When the rod is thus centralized, a dowel of brass tubing is put in,
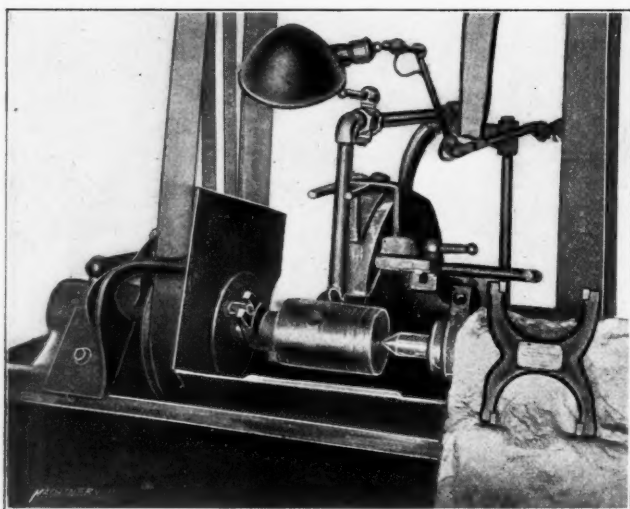

Fig. 11. Grinding Pistons

which prevents disalignment and also conveys oil to the piston-pin bearing.

For testing the parallelism (both vertical and horizontal) of the rod bearings, the fixture shown in Fig. 14 is provided. In operation, two ground arbors which are tight-fits in the rod bearings, are inserted, and the rod laid in the fixture as shown. A pair of flat springs A, press the smaller arbor against the inserted hardened and ground plugs opposite them. A similar pair of plugs are seen in the other end of the fixture; between these and the arbor is inserted the taper strip seen in the foreground. The taper is such that the cross lines which are about ¼ inch apart each give a reading to 0.001 inch. The two flat strips attached to the lower end of the fixture are so placed for convenience in reading any variation in the position of the taper strip. As all four horizontal surfaces on which the ends of both arbors lie are ground to the same plane, any wind in the connecting-rod is seen by the failure of all four points to touch at the same time.

Bevel-gear Templet Milling Machine

A pair of bevel gears are used to drive the short, vertical, commutator shaft from the cam-shaft of the motor, and as the relative positions of the commutator to the cam-shaft and main shaft of the motor must be accurately maintained, the necessity of correctly cut and carefully mounted gears is apparent. The arrangement of these gears is shown in Fig. 3 of the article referred to in the March issue. For producing these bevel gears a specially designed machine is employed, which is shown in Fig. 4. The machine is one of the templet type, which templet or form (seen on the arm at the top of the machine) is primarly developed by rolling contact with a rack. This produces a magnified tooth form which is mathematically correct, and even if it contained any errors these would be reduced in the actual work in the same proportion which the gear tooth bears to the form.
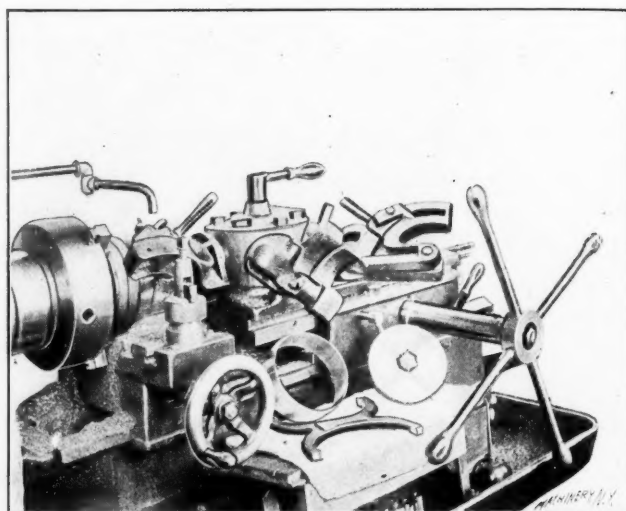

Fig. 12. Turning a Spherical Ring

The machine consists of two principal parts: the work spindle and its driving and indexing mechanism, and the cutters with their driving mechanism. The cutters are driven by round belts, at a high speed, and are mounted on geared spindles which are carried in two vertical slides, which, in operation, have a reciprocating motion on lines divergent from the cone center of the gear to be cut. The cutting edges of the cutters are thus always traveling along lines which become the clearance lines of the gear tooth. The gear blank is roughed out on a special gashing machine as the templet milling machine is not intended for roughing.

The work spindle is carried in the head, which has a working range of 75 degrees between the horizontal and vertical planes. This head is locked to the movable graduated quadrant, which is pivoted at a point coincident with the center of the gear. The work spindle has an end movement of several inches, for convenience in changing the gear blank, and has a draw-in arbor attached to the hand-wheel seen above the index plate, for locking the gear blank in position. The index plate is seen at the top of the work spindle. The index trip is set at the desired position on the rear slot of the stationary quadrant. In operation the large cam under the work spindle raises the pivoted quadrant to which the work spindle is locked, and gradually feeds the work forward between the two cutters, which are gradually forced to change their position by the action of the large tooth form entering between the two rolls on the cutter slide arms. The indexing is, of course, automatic, and occurs at the position of the cam shown in the engraving. This cam has, as shown, an edge consisting of a series of small steps, rather than a gradual curve, and is so geared to the cutter spindle mechanism that the work is fed into the cutters at the ends of the stroke of the cutter slides, rather than during a cut. The index mechanism shows careful thought in its design, in that the index pin enters the slots in the index plate in such a manner as to have no sliding contact on the master edge of the slot. An automatic trip stops the machine when the gear is finished. This machine is one of a series which was built by this company (then the Leland & Faulconer Manufacturing

Company) in 1898-1899, for producing either soft or hardened and ground bevel gears, the machine being designed to produce finished soft gears, or semi-finished gears for hardening.

Commutator Testing

Fig. 15 shows a fixture employed for testing the accuracy of the spacing of the contact points of the commutator. This fixture consists of a central portion carrying the commutator shaft, and of an outer graduated steel disk movable on the central part of the fixture. In operation, a commutator is slipped on over the stationary shaft and the bearings adjusted. The commutator brush is then placed on the shaft and locked in place, leaving the commutator body free to be revolved. A battery and coil which are a part of the fixture, indicate the electrical contact by the buzzing of the coil. The pointer is then put in place and clamped, and the commutator turned until a contact is indicated. The large outer disk (about 18 inches in diameter) is then turned around under the pointer until one of the 90 degree graduations are directly under the pointer. The commutator and pointer are then turned to bring the other contacts to the brush, and their variation read on the large disk, which is graduated in degrees at four equi-distant points around its edge. The requirement is that the commutator contacts be spaced 90 degrees apart, and the variation allowed is only one-half a degree, as the relation of the firing to the piston and valve movements must be very exact.

A COLLECTION OF MACHINE SHOP RULES

ETHAN VIALL[*]

A booklet has recently been issued by the H. Mueller Mfg. Co., Decatur, Ill., for the employes of the shop, containing a number of directions for the use of tools. As these rules will doubtless be of general interest, the essential points are given below.

Rule 1. A file must not be used as a hammer, chisel or pry.

Rule 2. Do not use a monkey wrench as a hammer.

Rule 3. A wrench used on the head of a bolt or screw, or on a nut, should fit closely, otherwise it will gradually round the corners.

Rule 4. Never use a large wrench on a small bolt, screw or tap, without considering the amount of strain that the bolt, screw or tap will stand.

Rule 5. When chucks are placed on the lathe spindle, be sure that the threads on the spindle and in the chucks are cleaned and oiled. Then screw the chuck on by hand within one-quarter turn of the shoulder, and finally give it a quick turn by hand against the shoulder. This will tighten it sufficiently to keep it in place, without causing difficulty when taken off. The chuck should be oiled at least once every twenty-four hours, though a more frequent oiling will do no harm.

Rule 6. All working parts of tools should be kept well oiled. The shanks of the tools should also be oiled slightly and
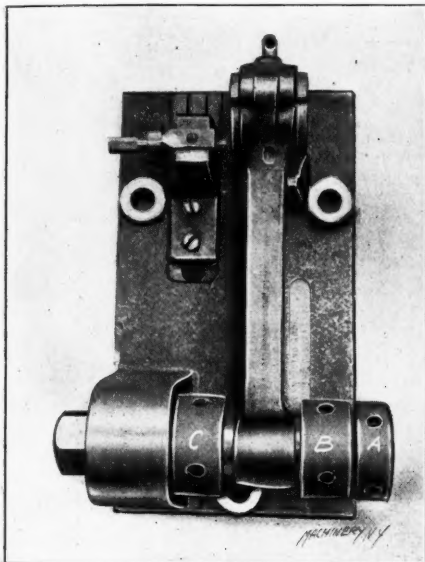

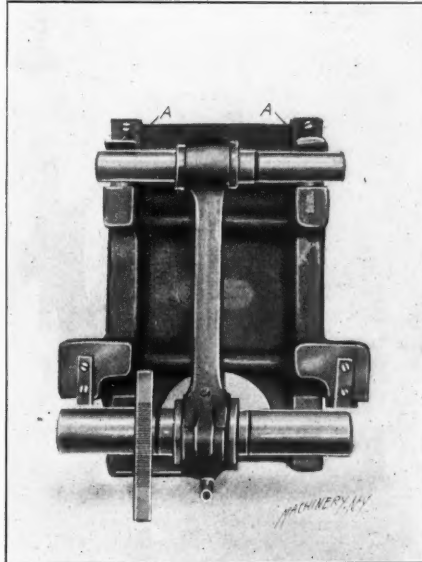Fig. 13. Fixture for Testing the Relative Lateral Positions of Connecting-rod Bearings

Fig. 14. Fixture for Testing the Parallelism of Connecting-rod Bearings
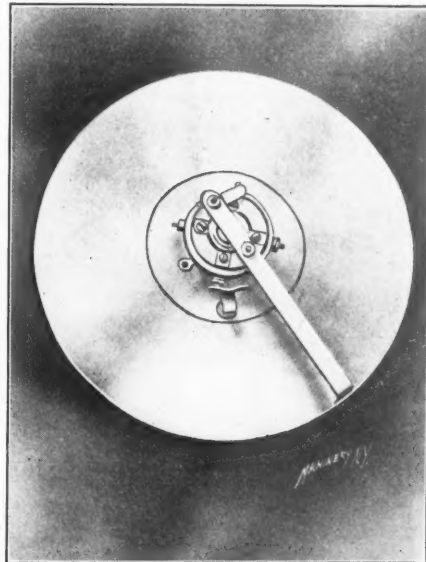

Fig. 15. Fixture for Testing the Accuracy of Commutator Contact Points

Fig. 12 illustrates a nice piece of screw machine work in the brass shop. The ring seen leaning against the machine is of bronze. The diameters of these rings range from 6.497 inches to 6.500 inches and the bore from 5.878 inches to 5.880 inches. The outside is spherical in shape, and the ring forms a part of the rear universal joint housing that the rear axle driving shaft casing pivots and also slides in to compensate for the rear spring action. Slight variations in size and a fine finish are necessary to make this joint oil tight. A casting is seen in the machine, and a roughing cut is being taken from the outside. It has already been rough bored, enough metal being left for a fine finishing cut to be taken after the outside is finished. The castings have heavy flanges for inside chucking, so that little trouble is experienced by their springing after being parted. The illustration clearly shows the construction of the spherical turning tools, and two of the gages used.

* * *

German engineers were comparatively slow in adopting the steam turbine for ship propulsion until its merits had been sufficiently proved; but at the present time the realization of the importance of steam turbines in connection with both merchant and war vessels is clearly evidenced by the fact that nearly all German ship-building yards are now building steam turbines.

wiped, before inserting into the holders, to keep them from rusting. The holes in the turrets which are not in use should be plugged up with wooden plugs, so that the chips cannot enter and get into the working parts.

Rule 7. Never accept a taper shank drill from the toolkeeper if it has a broken or distorted tang. It may cause damage to the socket.

Rule 8. Gages of all kinds must be handled with care. Never force a piece of work into or onto a gage. Do not slip a ring gage over a set-screw on the machine and allow it to remain while the machine is operating. The constant jarring of the machine will cause the gage to work on the set-screw, and gradually spoil it. Threaded plug gages should be screwed into a cap when not in use, in order to protect the threads.

Rule 9. Tools should not be forced into the holes in the turret, because it is then very difficult to remove them; the hole in the turret may be enlarged, which would damage it for use with regular tools. The tool shank should fit easily, so that it can be inserted by hand.

Rule 10. If a tool cannot be removed from the turret, try some of the following rules for removing it. For centers: If after loosening the set-screw, the center cannot be removed by hand, tap it lightly with a lead hammer; do not tap it too hard; if the center is flattened on one side, use a monkey

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* Associate Editor of MACHINERY.

wrench to give it a turn; centers in hollow spindles should be driven out with a rod, from the rear. For tool holders: These can generally be loosened by applying a monkey wrench to give them a turn. For tap holders: The last piece of every job should not be taken out of the chuck until the tap holder has been extracted from the turret. If it is too tight to be moved by hand, the tap in the holder should be screwed into the work; then run the carriage back, and pull the tap holder out of the turret; this method can also be applied for adjusting the tap holder to the work. For die heads: These can be removed by running the die on the last piece of work, and moving the carriage back in the same way as for tap holders; if a self-opening die, hold the lever of the die-head, so that the chasers cannot open up. For chasers: A bar of lead or a piece of wood should be used to tap the chasers lightly, if they cannot be extracted from the die by hand.

Rule 11. A wrench, hammer or a piece of brass or steel should never be used for adjusting the tools in the turret, even a fraction of an inch. The tools should be tapped lightly with a lead hammer.

Rule 12. No hard material of any kind must be laid on the ways or bed of a lathe. The unused portion of the lathe bed should be covered by a smooth board.

Rule 13. When putting a tool into a turret or holder, turn the flat side of the shank so that the set-screw will rest on it. If the set-screw is tightened at the round part of the shank, it will set up a burr. The set-screw should never rest on the extreme end of the shank, as it is likely to tip the tool out of true.

Rule 14. Handle the shifter of the counter-shaft with care. If the machine is running at full speed, rest the shifter at the neutral position for a few seconds before reversing. Make the reverse as gradual as possible. Slipping and stretching of the belts, working out of the clutch, breaking of clutch fingers, loose counter-shafts, and the heating of bearings, are some of the bad effects of sudden reversal at high speed.

It will be seen that the foregoing rules were primarily intended for the men in the turret lathe department. Several of the rules may seem unduly elaborate, but often turret lathes are operated by comparatively inexperienced help.

* * *

THE LIVE PRESS

C. TUELLS

Business was booming at the old novelty shop, and lots of orders were in, some of which were marked "special rush" in large red letters, so it was only natural that the press department should be taxed to its full capacity for turning out punchings. The floor was littered with scrap-brass and the fly-wheels of the presses were spinning merrily around to the tune the dies played as they snapped through the stock.

During the rush an unlucky press-hand had cut a scallop out of the end of one of his fingers in spite of the warnings of Jim (the "master-mechanic" of the press-room), to keep his fingers clear of the dies. Press-hands were not hard to get, so the next morning a new boy appeared on the scene to take his place. The foreman had brought him around and told Jim to start him at work, so he was soon initiated into the mysteries of running a punch-press, and though the piece-work price was only thirty cents a thousand, the counter on his press was soon clicking around as fast as any of those on the other presses.

The boys working on the nearby presses were jealously watching him and speculating as to how much he would make and how long he would last—just as the old hands in any shop always keep tab on a new man to see how he gets along and what mistakes he makes.

The new boy was a hustler; in fact the other press-hands decided he was "killing the job"—so fast did he work—and, full of envy, they began to put their heads together to devise a way to "do" him. After much scheming they hit upon an idea, and while he had gone to the stock rack for more brass they detached the wires from an electric switch and connected them to the back of the new boy's press in such a way that a foot on the treadle and a hand on the press-bed completed the circuit.

Back came the press-hand with his arms full of sheet brass, all stripped and ready to be punched. He sat down on his stool, started a strip of stock under the die, and put his foot on the treadle—but no, he didn't press it—the treadle pressed him. He jumped back about two feet, looked at his hands, at the stock, and at the press; they looked all right, so with an expression on his face that was partly pained and partly puzzled he pluckily sat down and tried it again, with the same result—only more of it.

"Shocking" was a new and decidedly disagreeable experience to him, and he didn't understand it, so he went off looking for Jim, the cure-all for press troubles. The rest of the boys were convulsed with laughter, but before Jim got there they had replaced the wires, and, naturally, he found the press all right, and though the new press-hand looked on with fear and trembling, Jim tripped the press a few times and told him to get to work again.
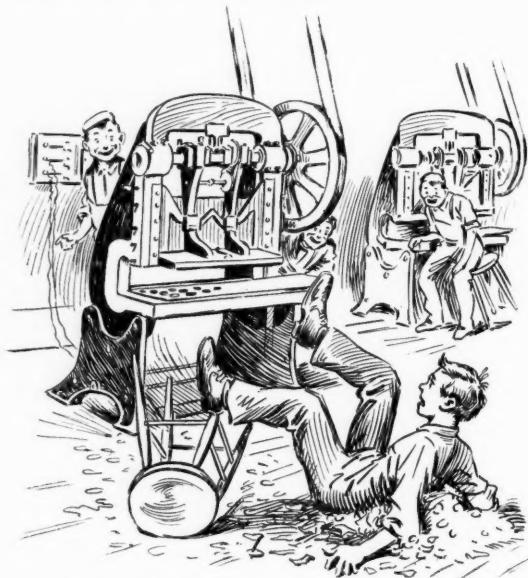
"Over he went, stool and all, into a pile of scrap-brass"

As soon as Jim had left, back went the wires while the press-hand's back was turned, and by the time he was ready to start, the press was ready too, and the minute his foot touched the treadle, over he went, stool and all, backward into a pile of scrap-brass, letting out a yell that would have done credit to Sitting Bull. The other boys could hold in no longer, and amid their shouts of derisive laughter he got up, gave one last look at that press, and bolted for the door, grabbing his hat as he ran—the worst frightened boy that shop had ever seen, and if the expression on his face counted for anything he should be going yet.

Next morning a large placard appeared in the office window. It read: "BOY WANTED."

* * *

A great deal has been written from time to time decrying the mechanic who does his work so that it is merely "good enough." However, there is something to be said in favor of the man who does his work merely "good enough," provided it is always as good as required. It is not in harmony with modern manufacturing conditions to finish work to a thousandth of an inch, when a limit of a thirty-second inch is amply accurate, and it is no special virtue in the man to carefully work within close limits to the dimensions on the drawing without using his judgment as to which dimensions should be as accurate as possible and which would be "good enough" if they were within one-sixteenth inch. In fact, the man who is able to judge for himself, in every case, exactly when his work is "good enough" for each specific purpose, is really the best mechanic. In years gone by, exceptional skill only was supposed to be the final qualifications of the master of mechanics, but to-day skill alone is not enough. It is skill combined with sound judgment and good common sense that is required in any successful mechanic, and the man who is able to decide for himself in every case exactly when his work is "good enough" for the purpose intended, is really the best man to have around a manufacturing plant.

POWER HAMMERS AND FORGING APPLIANCES*

JAMES CRAN†

Power hammers, previous to the advent of steam, were of the helve and trip types, usually operated directly by the shaft of a water wheel, and principally used in the manufacture of wrought iron and steel. They were crude and cumbersome, but they were equal to the needs of a past generation of iron and steel workers, who were more noted for the thoroughness with which they did their work than the speed with which it was accomplished.

The steam hammer was invented by James Naysmith about 1842. Naysmith's hammer was direct acting, and was a decided improvement over the helve and trip types; but it was defective in several ways. The valves were operated by hand, and it was often difficult to raise the ram immediately after a blow was struck. This had a tendency to chill the metal being worked. The steam hammer remained in this condition
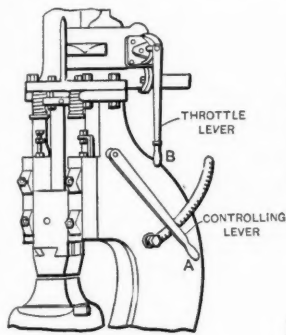
Fig. 1. Single Frame Steam Hammer, showing Common Arrangement of Levers
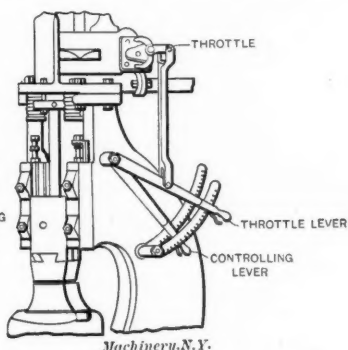
Fig. 2. Improved Arrangement of Throttle Lever

until Robert Wilson applied a valve motion which enabled the blows to be regulated both in speed and force, thus bringing the hammer at all times under perfect control of the operator.

The steam hammer has been the most potent factor in the development of the iron and steel industry. When considering the important part it has played in the development of machinery, and the effect it has had upon progress and civilization, it is natural to suppose that no pains would have been spared in perfecting this useful tool. This has, however, not been the case, and the steam hammer of to-day is but slightly superior to that made by Naysmith and Wilson. The improvements made since it was originally invented have mostly been on the valves, the guides for the ram and the general construction of frames. Minor details, in the majority of cases, have been left to take care of themselves.

Take, for example, the arrangement of the hand levers on most of the single-frame hammers in general use. It will be found that the greater part of them are made as shown in Fig. 1. To manipulate levers arranged as shown, the operator is placed not only in a cramped, awkward position, but so that he can only with difficulty see the work being done. The controlling lever A being held in the right hand, makes it necessary for the operator to use his left hand for the throttle lever B. When working under a full head of steam, his left arm comes directly in front of his face, obscuring his view of the work. He must remain in this position until the operation on the work is completed; should he release his hold upon the throttle lever, the jar of the hammer would immediately bring that lever to the perpendicular position and shut off the steam. The operator's view of the work being obscured is also often responsible for his mistaking the signs which must necessarily be used while work is being done at a steam hammer on account of the noise. On some makes of hammers this defect has been overcome by placing both levers on the same stud, and operating the throttle by means of a connecting rod connecting the lever with a short lever directly attached to the stem of the throttle valve, as shown

* For further information on this and kindred subjects, see MACHINERY, May, 1909: Anvils and Forges, and the articles there referred to. See also MACHINERY's Reference Series No. 44: Machine Blacksmithing, and No. 45: Drop Forgings.
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in Fig. 2. This permits the operator, at all times and under all conditions, to get an unobstructed view of the work.

The methods of attaching the levers may also be improved. The usual method for attaching them is shown in Fig. 3. The lever hubs are fitted or at least placed on round stems and kept from turning by keys. A taper pin is driven through the hub on the lever and the stem, to keep it in place. It is, generally, but a very short time before levers attached in this manner work loose, no matter how well they may be fitted. Lost motion is an annoyance on any kind of machinery, but is actually dangerous on a steam hammer. If the levers were made with a binder across the end of the boss, as shown in Fig. 4, and fitted to square stems, there would be little danger of lost motion, or of the levers working loose; and their removal when repairs are necessary would be an easy matter compared with removing pins and keys.

There is also room for improvement on the common method of fitting and attaching the anvil-block to the base. Almost invariably the male part of the dovetail is a projection of the anvil-block and fits into a recess in that part of the base which projects through and a little above the flange which forms the base of the frame, as shown in Fig. 5. Should the key which is necessary to hold anvil-block and base firmly together be driven in too tight, the chances are that the side of the recess will be broken away. When this happens, there is no possible means of effecting repairs and the base must be replaced by a new one, which can only be done by disconnecting all pipes to and from the hammer and raising the whole frame to allow the old base to be removed and a new one placed in position. Apart from the work and expense, the hammer is out of commission from one to two weeks. If the dovetailing were reversed, making the male portion part of the base, as shown in Fig. 6, it would be almost impossible either to break or damage the base acci-
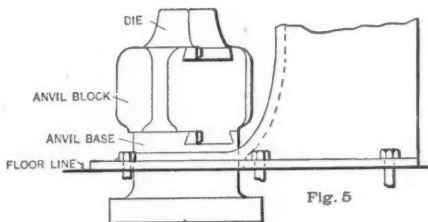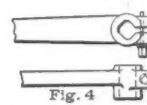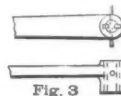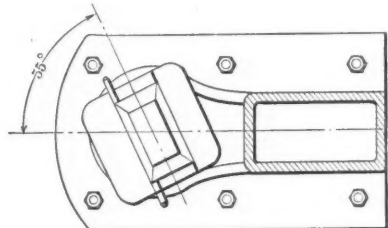

Fig. 3. Common Method of Attaching Throttle and Controlling Levers Fig. 4. Improved Method of Attaching Levers Fig. 5. Anvil and Dies of Steam Hammer set at an angle with the Frame; also shows Usual, but Objectionable, Method of Dovetailing Fig. 6. Improved Style of Anvil Block and Base

dentally, as the driving of a key however tight would only tend to compress it. Should the anvil block happen to be broken, the replacing of that would be but a trivial matter compared with replacing the base.

Upon nearly every other class of machinery weaknesses and defects of the kind mentioned have either been overcome or guarded against by placing the pieces most liable to break in positions where removing or replacing them can be done at the least expense. The probable reason for the details of steam hammers not receiving the attention that is usually given to machinery used in other branches of metal working may be that designers as a rule never have any practical forge shop experience apart from that taught in the industrial departments of schools and colleges, which at the best is only elementary and does not, usually, bring them in contact with forging appliances other than those used by hand around the anvil. Much valuable information relative to steam hammers and other forging appliances could be gathered from the blacksmith, who has every opportunity of not-

ing their efficiency, and their weak points as well; but suggestions from him, no matter what his experience may be, are seldom considered, rarely adopted, and often have a similar effect upon the manufacturer and designer that a red rag has upon a bull.

Nearly all kinds of machinery used in the different branches of metal working, outside of the forge shops, are constructed so that they can be adjusted or set to work to any angle. Tool equipments for any particular class of work are made and supplied, and all the data and instructions that will insure that the machine will give satisfaction in turning out work to its full capacity are given. When a special tool or a fixture for some particular piece of work is required, it is designed and constructed in strict accordance with mechanical principles. Steam and power hammers, however, are supplied with no tool equipment whatever, more than a plain-faced pair of dies which are of comparatively little use in the making of forgings without an equipment of tools to be used in connection with them. Such tools the builders of hammers do not supply, nor do they generally give any information that could be turned to good account in making them. It
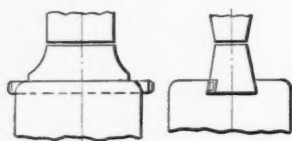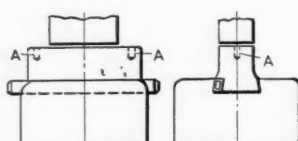

Fig. 7. Common Form of Dies   Fig. 8. Improved Form of Dies for General Use

is usually "up to the blacksmith" who has to use such hammers and appliances to design and construct such tools and fixtures as facilitate the making of forgings and make the machines paying investments.

Steam hammers are built in a variety of styles to suit the different classes of forging. The smaller sizes are of the single frame type, while those intended for the heavier work have an arched or double frame. For medium weight and light forging, the single frame hammer with the anvil and dies set at an angle of from 55 to 60 degrees from the frame, as shown in Fig. 5, will be found to be the most suitable, as work of any length can be forged either across or lengthways of the dies without its coming in contact with the frame.

Nearly all dies supplied with steam hammers are tapered from the shank to the face, as shown in Fig. 7, and are only suitable for plain straight forging, as it is impossible to work close up to a shoulder on a forging, on account of the taper, or to break down work except by using special tools, as the faces of both dies are the same length. If the dies were made as shown in Fig. 8, where the lower die is considerably longer than the upper one, with the sides of both perfectly straight, several advantages are gained over the more common shapes. The square sides allow of working close up to shoulders, and the extra length of the lower die permits of breaking down work without the use of special tools. Work is also much more easily straightened, and there is more space upon which to place formers or special tools. The hole at each end of the lower die, as shown at A, adds considerably to the utility, as these holes can be used for stakes to keep formers from moving while the dies are being used. Work of irregular shape can also be butted against the stakes while the hammer is used to finish some portion that otherwise would have to be done by hand. Forks could also be used to keep spring swages from being moved with the work when it is forced or drawn through them.

To make a steam hammer as useful and handy a machine in the forge shop as a lathe with a taper attachment is in the machine shop, a lower die as shown in Fig. 9, can be used to draw and finish tapers to any angle. The rougher part of the work is done on the rounded end B, and the finishing on the adjustable end D. The level portion C in the center can be used for flat work. The adjustable section D of the die is about one-third of the entire length, circular in shape, and corrugated on the lower side which is provided with a T-slot. A T-headed bolt fits into the slot, and the adjustable section is held firmly in place at any angle by a wedge-headed bolt E, which is passed through a slot in the T-bolt and is

tightened by a nut on the end which projects through the other end of the die. When the end of the adjustable section is raised above the level of the face of the die, as shown by dotted lines, a piece shaped as shown at A can be placed on the center of the die to prevent the upper die coming in contact with it.

To set dies of this kind accurately to any desired angle, the adjustable gage shown in Fig. 10 should be used. The gage is jointed at all the corners, and locked at any angle by means of a thumb-screw. It can be adjusted by means of a protractor and is used by placing it between the upper die and the adjustable section in the lower one while the bolt that keeps it in position is loose.

The arrangement of piping to and from hammers is also worthy of consideration. Generally both the supply and exhaust pipes are placed overhead, where they offer an obstruction to the free use of jib cranes, which are essential in the handling of heavy work. Besides, any steam that is condensed in the supply pipe, is supplied to the hammer in the form of water, especially when the hammer is installed any distance from the point at which the steam is generated. When water is supplied to a hammer in any considerable quantity, it generally finds an outlet other than the drip cocks and is one of the greatest annoyances to the workman. If it gets on the dies it is spread in a fine spray in all directions when a blow is struck.

The trouble with leaking water can be overcome to a great extent by placing both supply and exhaust pipes under the level of the floor and providing the supply pipe with a trap which would take care of the greater part of the water caused by condensation. The fact that the steam is supplied from below instead of from above would tend to prevent water reaching the cylinder of the hammer in quantities sufficient to cause trouble. The absence of overhead pipes would allow of the free use of cranes or any other conveying devices.

Among forging appliances the steam hammer is paramount; it can be used for any kind of forge work from the lightest to the heaviest; but for some of the lighter grades of forging some of the lighter types of power hammers may be used with equal, and perhaps better, results than could be obtained with the average steam hammer, because they are lighter and capable of striking blows much more rapidly. When the term power hammer is used without qualification it
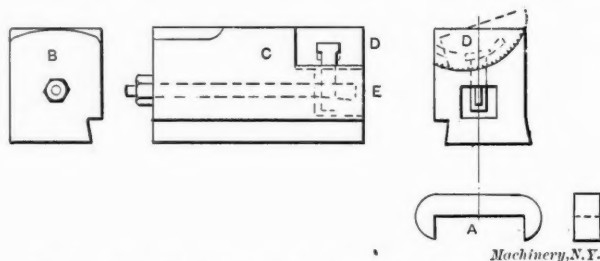

Fig. 9. Adjustable Lower Die for Drawing and Finishing Tapers

applies to the types of hammers that are operated by a belt from a countershaft almost directly over them. The belt is just long enough to clear the lower side of the pulley attached to the hammer; it runs constantly and is rendered operative by a tightening pulley or idler controlled by the foot of the operator. Hammers of this type are generally referred to by forgemen as trip hammers. The term is misleading, and is only a survival of the name applied to one of the earliest types of power hammer now almost obsolete. Power hammers are built in a variety of different styles, each of which is designed with reference to its adaptability to certain kinds of work that may be done by them somewhat more economically than by the other types.

The types of power hammer best adapted for general forge work are those with the ram running in guides. This arrangement insures their striking a square blow upon any size of material within their capacity. They require less adjusting than most of the other types, and their utility is such that they can be advantageously used for any operation in the making of light forgings with the exception of upsetting.

The helve hammer is extensively used for the making of any kind of light forging that can be done in open dies such

as round work, edged tools, cutlery and springs. On this type of hammer the head is mounted on the end of a wooden beam which is cushioned both on the upward and downward stroke either by blocks of rubber or springs, making the blows, which can be delivered with great rapidity, very elastic. These hammers, however, are poorly adapted for general forge work because the head is raised and returned upon a radius which makes adjustment for each size of material necessary. If not properly adjusted, the side of the work nearest to the fulcrum will be drawn thinner than the side away from it. Generally the arrangement of dies in helve hammers as they are supplied by the manufacturer are as shown in Fig. 11, the rounded ends being toward the fulcrum. This is all that is necessary when the hammer is to be used exclusively for the drawing of stock to smaller dimensions, but for general forging they should be reversed as it is often necessary to spread stock to greater width, which can only be done to advantage when the rounded ends of the dies are accessible. The dies could be used equally well for all the purposes for which helve hammers are generally used if placed cross ways in the head and anvil.

When floor space is an item of importance, the upright power hammer, of which there are various styles, is more compactly built, equally as efficient, and can be installed and manipulated in less space than most of the other types.
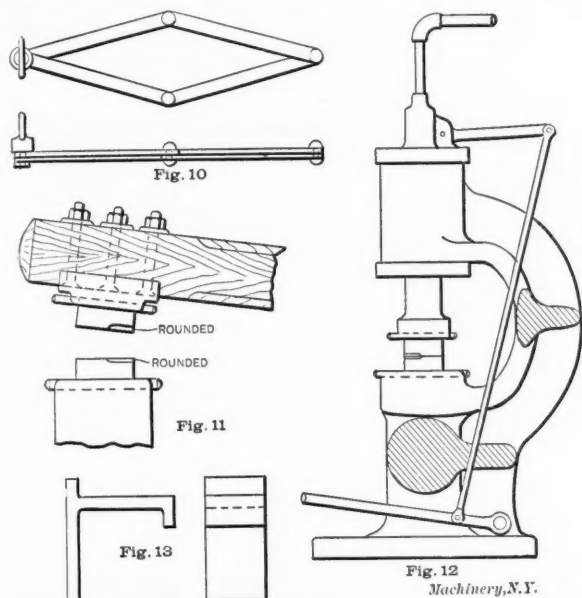

Fig. 10. Gage for Setting Adjustable Die to any angle. Fig. 11. Common, but Objectionable, Way of Placing Dies in Helve Hammer. Fig. 12. General Appearance of Pneumatic Hammer for Light Forging. Fig. 13. Piece that can be forged to Advantage in the Forging Machine

Lately marked attention has been given to the development of pneumatic or compressed air hammers, which without doubt is a step towards progress. Pneumatic tools have proved their efficiency and utility in other branches of manufacturing, and there is no apparent reason why they cannot be advantageously used in forge shops, providing they are designed and constructed for that class of work. Compressed air is quite often used for the operation of ordinary steam hammers and has proved to be a very efficient substitute; but when it is possible to operate a hammer by steam direct, it can be done as effectually, and at less cost, than would be the case indirectly through an air compressor.

With the modern pneumatic hammer it is an entirely different case, as it is built self-contained with air compressor attached, and can be operated either by belt power or an attached motor, the advantage of which needs little explanation. No piping to speak of is required, power is used only while the hammer is being operated, and its utility for work within its capacity combines most of the advantages of steam and belt driven hammers.

There is another type of pneumatic hammer that so far has not received much thought or attention, but which has proved itself to be a valuable addition to the equipment of forge shops where it has been tried. The working parts are constructed upon the same principle as the hand pneumatic hammer used for chipping, and is simply larger and mounted upon a frame in the shape of a G clamp supported by a column and base as shown in Fig. 12. Hammers of this type are so compact that they can be installed and operated in about half the space required for any other type of hammer of the same capacity. They can be used for the very lightest of forge work and the exhaust from the cylinder can be utilized to keep the dies free from scale, which is important when smooth, clean forging is essential.

For making duplicate forgings in large quantities, there is no forging appliance that is so extensively used as drop hammers. As the term implies, the heads of drop hammers are raised to sufficient height for the required blow, released, and allowed to fall on the work being forged, after the principle of pile drivers. There are various methods of raising the heads of this class of hammers. The most common for forge work is by friction. A hardwood board is attached to the hammer head and passed between two rolls which rotate in opposite directions on the top of upright guides. These rolls are rendered operative by a mechanism controlled by the foot of the operator. When the head has been raised to sufficient height, a projection on the head engages a dog which releases the board from the rolls and allows the head to drop upon the work. Blows may be struck automatically or their force can be regulated at the will of the operator. Drop hammers are designated by their falling weight and are built in all sizes up to 3,000 pounds, which is the limit at which a friction drop can be successfully operated.

Duplicate forgings larger and heavier than can be economically made by drop hammers are either made by steam drops, which are practically steam hammers designed for the making of forgings in dies. Hydraulic presses may also be used.

The only disadvantage in using hammers of the kind mentioned is that the dies used in connection with them must necessarily be made with from 3 to 5 degrees of draw in the impressions to allow of easy removal of the forgings after each blow is struck; otherwise scale would accumulate in the impressions and be worked into the surface of the pieces being made. Hot material left for any length of time in dies has also a tendency to soften them. It is therefore obvious that forgings of a shape other than round or oval cannot be made perfectly parallel on all sides except by more than one forging operation.

In the making of duplicate forgings such as are used on cars, wagons, agricultural implements, etc., where smooth surfaces are not so essential as shape, strength, and level bearings, there is no forging appliance that can be used to greater advantage than the modern forging machine. Take, for example, a forging of the shape shown in Fig. 13; it is plain, and looks as if it should not be difficult to make. This however, is just the kind of work for which the drop forging process falls short. By being roughly bent to shape it can, however, be forged complete at one stroke of a forging machine.

The bulldozer is also worthy of attention although it can not be used to advantage for work other than bending. In the modern forge shop it is indispensable for that work alone, as there is no bending job, however complicated, that can not be done by it with properly constructed fixtures.

If an equal amount of thought, ingenuity and skill were devoted to the improvement of forging appliances and methods of working hot iron and steel, that has been given to the manufacture and finishing processes in the machine shop, it would be just as easy for the blacksmith to make light forgings within 1/16 inch, medium weight within 1/4 inch, and heavy pieces from 3/16 inch to 1/4 inch of finished size, as it is to turn out the shapeless pieces that must be hogged to shape by high-speed tools in the machine shop, where the part of the material that has been refined by hammering is removed, leaving the soft core for the finished product, at a cost out of all comparison with a good clean forging.

* * *

The making of flying machines is rapidly becoming a commercial proposition. The French company which has bought the French patent rights for the Wright brothers' aeroplane has, according to *Industritidningen Norden*, so far contracted for the building of more than 25 flying machines.

COIN AND MEDAL DIES

CHESTER L. LUCAS*

The making of dies for coins, medals, trade checks, etc., is a branch of the die-making trade apart from the general run of work. The conditions to be met are peculiar to themselves, and even in making dies for jewelry work more latitude is given, both in measurement and design, than is allowed in the best of medal work.

The steel used in this class of work is necessarily of the very best, as steel that would give satisfaction when made into dies for other work is often inadequate to stand the enormous pressure to which coining dies are subjected while in use. Different die-makers prefer different makes of steel for this class of work, and the best steel obtainable is none too good for coin and medal dies. Personally, the writer prefers Jessops' steel for these dies, on account of its uniformity and the fact that dies made from this steel can be hardened to a greater depth than is possible with other steels. Another point in favor of Jessops' steel is that it will not crack as easily if overheated during the hardening process; in other words, it will stand more abuse.

In making a set of coining dies for use either in the regular type of coining press or in the drop press, the first part to be considered is the ring shown in cross section in Figs. 1 and 2. The object of this ring is to confine the metal blank while being embossed between the top and bottom dies. The tendency is for the metal to squeeze out sideways from between the two dies when the blow is struck; but as this ring, which is a close fit around the dies, confines the metal to the space between the dies, it is obvious that if sufficient pressure
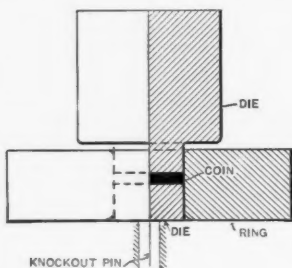

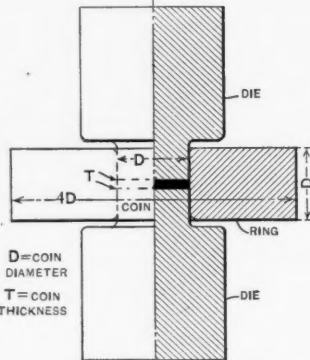Fig. 1. Coining Dies and Ring for Coining Press

Fig. 2. Coining Dies and Ring for Use in Drop Press

is applied, the metal must fill every impression in the dies, as it can go nowhere else. In making the ring to be used in a coining press, which is the modern machine for producing coins, the outside diameter is turned to fit the steel ring holder of the press, usually from three to four inches, according to the size of the press. For independent use in the drop press, the stronger this ring is made the better. A good rule is to have its diameter at least four times the diameter of the coin, and its thickness equal to the coin's diameter; thus, a coin one and one-half inch in diameter will require (when used in a drop press) a ring six inches in diameter and one and one-half inch thick. The hole in this ring gages the size of the coin, and should be ground and lapped to a mirror finish after the ring has been hardened and drawn to a dark straw color.

The next step is the turning of the die blanks. Fig. 1 shows a pair of dies and a ring for coining press use. In

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turning this pair of dies it is best and quickest to make the two dies in one piece and then, with the cutting-off tool, cut off that part to be used for the lower die, which as the illustration shows is simply a small piece of steel the same diameter as the coin and about half as thick as the coin's diameter. Every coining press is fitted with a knockout which automatically raises this lower die at the end of each stroke of the press, thus ejecting the coin and leaving the dies free to receive another blank.

Fig. 2 shows a pair of dies and ring for use independently in the drop press. The drop press is not an economical machine for making coins or medals, but is many times used in shops where there is no coining press or where the coin is too large to be struck in the coining press with which the shop is equipped. The process of striking up coins with the drop press is slow, because after each coin is struck, the ring
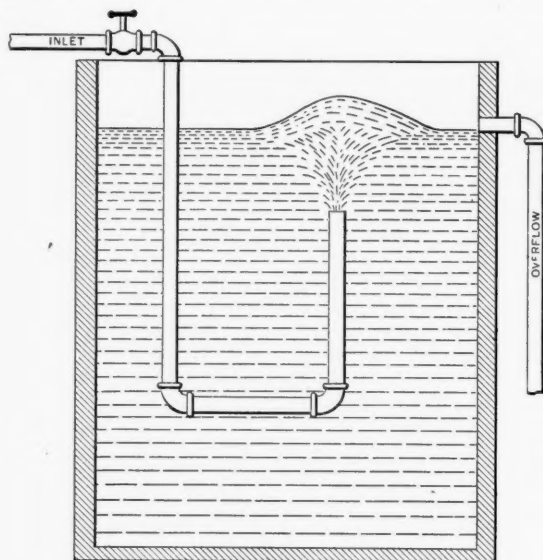

Fig. 3. Hardening Tank for Coining Dies

must be taken from the lower die (on which it rests during the striking) and the coin driven out with block and mallet. While this method seems crude, the work is equal in quality to coining-press work, and it often helps a small shop to "get by" on jobs which it otherwise could not do.

When finishing the faces of the die blanks, all borders, plain or knurled, and rings or circular panels should be turned before removing the blank from the lathe. The finished dies should be a sliding fit in the ring. The blank dies are now ready to be lettered and engraved with any required designs. After laying out the lettering on a piece of lead or cardboard to make sure of the way it is going to appear on the die, it is stamped into the steel die blanks with die-letters. Die-letters differ from ordinary stamping letters in that they are made reverse; and great care is exercised in the making to have each one as nearly perfect as can be made regarding size and shape. It is obvious that with good die-letters and careful stamping, taking pains to have the letters properly spaced and of even depth, the results will be satisfactory.

After all lettering has been stamped into the die and the roughness caused by stamping removed, the dies are ready for the engraving of any design that it is necessary to reproduce on the finished medal. When the design is very deep, most of the steel may be removed by hammer and chisel and only the finishing done with rifflers, gravers, etc. It is, however, best to avoid deep designs whenever possible, for they are very hard to strike up. If it is absolutely necessary to employ such designs, they should be placed on a sunken panel, as was the figure on the religious medal next to the "Eric Pape" medal in the center of the half-tone illustration, Fig. 4. At this stage of the die-making, the dies may be placed in the press and a lead impression taken to make sure that they are perfect in every detail before hardening.

In hardening these dies, or any dies which must withstand heavy pressure, the essential point is to cool the face of the die as rapidly as possible after the proper heat has been attained. For this purpose it is advisable to have a strong

jet of cold water run into the hardening tank in the manner illustrated in Fig. 3. If properly arranged, the water should come up like a geyser, and into this bubbling mound of water the red-hot die should be plunged, face down. After the first few minutes the face of the die will be glass-hard and the back end may be cooled more slowly so as to lessen the danger of cracking. In the case of the small lower die for coining press use, however, it is necessary to harden it all over; otherwise it would spread out when used and stick in the ring. As soon after hardening as possible, the temper should be drawn to a light straw color.

The matter of hardening coining dies is an important factor of the work, for the heavy pressure which they receive would quickly "dish" any die not hard enough, or crack any die that has been overheated or left too hard. To give an idea of the great amount of pressure exerted in embossing

is given by first polishing and then applying nitric acid for a few minutes.

Some designs, especially human heads or figures, are more easily engraved on a hub, which is afterwards hardened and struck into a piece of steel a little larger in diameter than the die to be made. When this impression has been struck deeply enough the piece of steel is held in the lathe chuck, and after centering up the impression, the die is turned in the usual way. An example of the results of this process is the Lincoln medal shown in Fig. 4. The keystone on the Masonic medal with its sunken letters was done in the same way, for the sunken letters were, of course, raised in the die and could not have been produced in any other manner. The hubbing process is also used when duplicate dies are to be made, as it is not only quicker, but each successive die is an absolute fac-simile of the original, and for this reason this

Fig. 4. A Collection of Coins and Medals struck in the Coining Press and Drop Press

United States currency, the following table, which appeared in MACHINERY, October, 1905, is given. The comparative coining properties of gold, silver, and nickel will be noticed by observing that the gold half eagle, silver quarter, and nickel five-cent piece require the same pressure of 60 tons, though the sizes and weights differ greatly:

Double eagle, gold	155 tons
Eagle, gold	110 tons
Half eagle, gold	60 tons
Quarter eagle, gold	35 tons
Standard dollar, silver	160 tons
Half dollar, silver	98 tons
Quarter dollar, silver	60 tons
Dime, silver	35 tons
Five cents, nickel	60 tons
One cent, copper	40 tons

Much of the pleasing effect of a good coin or medal is due to the polished or matt surface, as the case may be, which is given to it by the dies. The contrast between a polished background and a matt or frosted panel is very effective. The glossy finish is given to the dies by means of stoning and polishing with crocus in the lathe. The frosted or matt finish

process is extensively used in the government mints for making dies for currency.

The sheet metal stock from which blanks for coins are cut must be kept free from scratches and other defacing marks, and after cutting, the blanks should be annealed and dipped. The coins and medals in Fig. 4 were made of copper, brass and aluminum, and all were embossed in coining presses with the exception of the central medal, which was struck in a very heavy drop press.

* * *

Manufacturers in the United States and Europe appear to have a just cause for grievance in regard to the Argentine law of trade-marks. According to this law, anyone who first registers a trade-mark in the Argentine Republic becomes the lawful owner of the same, in spite of the fact that the foreign importer may be the sole owner of the mark in all other countries, and that his goods may be known everywhere by that particular trade-mark. In some cases it has been necessary for the foreign importer to purchase the right of his own mark from unscrupulous individuals who have secured the registration for the purpose of extortion.

THE MANUFACTURE OF PISTON RINGS*

JAMES McINTOSH†

While a great many other details of gas engines for automobiles have been standardized, there are hardly any standard dimensions or methods for making piston rings. Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot, etc. Cast iron, however, may be considered as the standard material for piston rings, but there are many kinds of cast iron. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and the ring metal must have sufficient spring. To get uniform results, great care should be taken from the start. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should
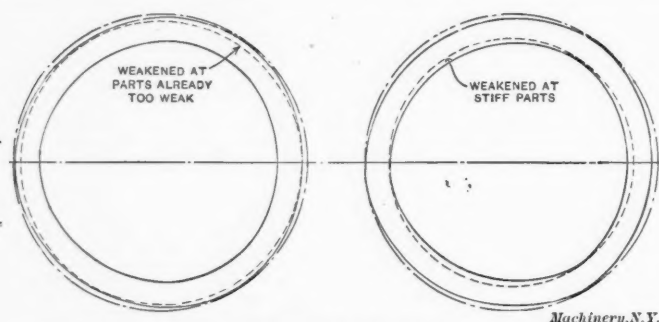
Figs. 1 and 2. Illustration of Result of Grinding Piston Rings on the Outside and on the Inside

be machine molded, as they will then be more uniform. When too much stock must be removed, the best part of the casting is removed, and the resulting ring will have a short life.

When machining, the ring blank can be rigidly held in a chuck by a flange cast on one end, which is somewhat larger in diameter than the blank proper. This flange need not be more than one-half inch thick; the edge should be tapered so that the chuck jaws will tend to draw the blank against the chuck. The ring may be further stiffened by the addition of an inside flange somewhat wider than the outside, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck, a stop may be cast on the edge of the flange which bears against the chuck jaw. If the rings are to be made in quantities, a very suitable tool for the machining is the Gridley automatic turret lathe. This machine can be arranged to turn, bore, and cut off the rings whether they be concentric or eccentric. The lead and timing of the cutting off tools may be such that the cutting off of the rings begins before the blank is completely turned and bored. Blanks five to seven inches long may be used successfully by this method.

To avoid trouble due to the fact that the rings lack the proper amount of spring, it is well to test the material after the first operation has been performed. A simple test is to have a taper block with a stop on it, and then cut a few of the rings from each cast and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. The opening at the joint in the ring before and after the test is noted to see that it is not in excess of the limits allowed for different kinds and sizes of piston rings. If the rings stand this test, it is safe to assume that all the rings in the same lot will be satisfactory when finished; but there is no reason why all the rings should not be tested in a similar manner when completed.

The second operation is the finishing of the sides of the rings to a standard width. This can be best done by the use of a magnetic chuck. The Heald ring grinder will be satisfactory for this work; it is regularly fitted with a magnetic chuck and has a micrometer feed to gage the width of the rings. The next operation is the cutting of the slot at the

joint of the rings. This can be done on a hand miller with a suitable fixture. There is some difference of opinion as regards the proper form of joints; some prefer the stepped joint, while others favor the diagonal slot. The stepped joint is more expensive to make and more difficult to fit and it is more easily broken than the diagonal joint. If the joint is open, say one-sixteenth inch, when made according to either system, the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. The writer personally prefers the diagonal joint.

The next operation is the finishing of the outside of the ring. Great care should be exercised in order to obtain good results with the larger sizes. These are usually closed with a suitable band, clamped between two surfaces, one at a time, and a light cut taken off the outside; but this method is rather slow in automobile building. The usual method in this manufacture is to have a suitable arbor and sleeve, the arbor being built up with a spindle having a fixed collar at one end, and an adjustable one at the other end. The latter should be fitted with a key or pin to keep the collar from turning while tightening the nut, otherwise the rings will be distorted. The collars should be made so that the diameter of the inner edge equals the diameter the ring is to be ground to, and the outer edge the diameter of the sleeve, so that the rings may be readily centered on the arbor, care being taken to see that the large diameter of the collar is far enough from the inside so that the grinding wheel can pass over the rings without touching the large diameter. The collars should be hardened and ground, so that the edge will keep its shape and hold the ring better.

A suitable sleeve is best made of cast iron. The sleeve may be light, but should have a band cast on each end to

PISTON RING DIMENSIONS
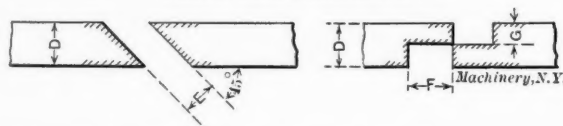
A = amount piston ring is larger than the cylinder
B = thickness of piston ring at heavy side
C = thickness of piston ring at light side
D = width of piston ring
E = width of cutter for 45 deg. diagonal opening in ring joint
F = width of cutter for stepped opening in ring joint
G = depth of joint step

Cylinder Diameters			A	B	C	D	E	F	G
8	7¾	7½	7¼	7/32	¼	9/64	9/16	15/32	11/16	9/32
7	6¾	6½	6¼	3/16	3/32	⅛	½	13/32	13/32	¼
6	5¾	5½	5¼	5/32	3/16	7/64	⅜	11/32	¼	3/16
5	4¾	4½	4¼	⅛	3/32	3/32	5/16	9/32	13/32	⅛
4	3¾	3½	3¼	3/32	⅛	5/64	7/64	7/32	5/16	7/64

keep it in shape, and should be provided with a lug with clamp screws at each end. The sleeve is more easily removed when it is split and then clamped by the lug screws. The hole in the sleeve is bored to fit the large diameter of the collars on the arbor.

There is one question of marked importance when using this method. Assume that the rings are too large in diameter. Then, when slotted, the circumference of the ring when closed is greater than that of the sleeve inside, causing the joint to crowd. Again, if the ring be too short, or open at the joint, the ring will touch on three or more points, and the irregularities which the grinding is supposed to correct will be increased, and the ring may be worse than before grinding. The writer would recommend that if a joint is desired with least amount of end clearance, the ring be ground a certain fixed amount open and that allowance for that amount is made on the diameter when grinding.

To correct irregularities on the outside diameter of the piston ring, by either turning or grinding on the outside is incorrect. Assume, for example, that a ring shows high spots when put in a cylinder. The high spots are due to excessive bending at those points, and the low spots to stiffness, which prevents the ring from conforming to the bore, or, in other

words, the stiff parts do not touch the bore. We cannot, therefore, correct the high spots, which are weak, by removing more stock from those points by grinding on the outside, but if we reverse the method and grind on the inside, then the irregularities on the outside will be corrected. The high spots on the outside cause the part opposite on the inside to be further from the center of the arbor or sleeve, and the low spots on the outside will be nearer the center, and when grinding on the inside, these will be the first points to be touched by the wheel. When grinding, these stiff portions will become weaker and tend to bend more, and by leaving the weak spots alone the stresses in the ring will be equalized and there will be a uniform bending all around. This is illustrated in Figs. 1 and 2. Fig. 1 shows the effect of grinding a piston ring, when out of true, on the outside. Dash-dotted line shows true bore of cylinder; full line, piston ring out of round; and dotted line piston ring ground on the outside. Note how the weak parts of the ring have been made still thinner by grinding. Fig. 2 shows the effect of grinding a piston ring, when out of true, on the inside. Note how grinding weakens the ring at the stiff points, thereby equalizing the stresses and making the ring spring out at these points and bear evenly all around, as mentioned.

The accompanying table gives piston ring dimensions based on the writer's experience, and conforming to good average practice. The dimensions are so arranged that the same general sizes will suit four different ring diameters so that the tools and gages required are reduced to five sets to take

being no other guiding means than that of the hand of the operator. Were it possible to provide the instrument with quickly operated slides in two directions, the device would be a most convenient and accurate slide rule.

* * *

REMARKABLE PHYSICAL CHARACTERISTICS OF ROLLED MANGANESE STEEL RAILS

The Pennsylvania Steel Co. showed, at the recent convention of American Engineering and Maintenance of Way Association at Chicago, Ill., a remarkable exhibit of rolled steel rails, which had been bent and twisted to a degree almost unbelievable, considering the excellent condition of the pieces, after the tests. These rails differ from the manganese rails heretofore used, in that they are rolled instead of being cast. The rolled product is given a trade name of "Manard." The company succeeded in producing rolled manganese steel after several years of experiments, as the difficulties of rolling so peculiar a material on a commercial scale were hard to overcome. This steel has much the same red-hardness characteristic at the proper rolling temperature as high-speed steel. Ordinary rail mills are not applicable for the work, special designs of rolls and special rolling methods being necessary to achieve successful results; and the machinery is of extraordinary power and strength.

The rolled rails are much superior to the cast rails, and what this means may be inferred when it is known that the experience of the Boston Elevated Railway Co. shows that the
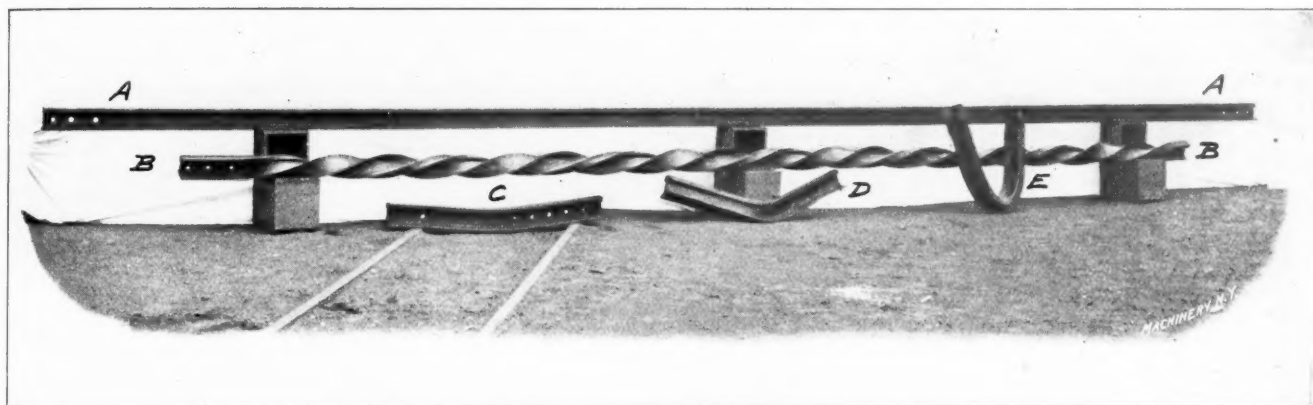
Rolled Manganese Steel Rails subjected to Twisting and Bending Tests

care of twenty cylinder diameters. The width D of the piston ring may, of course, be increased with a corresponding increase in wearing surface, but the dimensions given give satisfactory results. The inside of the ring should always be machined, because if the casting surface is not machined, irregularities in the casting will prove a source of trouble. The practice of annealing cast iron ring blanks does not seem desirable to the writer, as internal stresses due to cooling in a mold are rather remote with a ring blank of uniform thickness.

* * *

UNIQUE CALCULATING DEVICE

An interesting calculating table with some rather novel and unique features (*Graphische Rechentafel*) has been brought out by the Rechen-Apparate-Fabrik Fr. Schneider, Munich, Germany. The device consists of two tables with logarithmic scales printed on celluloid. The upper table or scale is made of thoroughly transparent material, so that the figures and graduations on the scale below can be read as clearly with the upper table in place as with it removed. The arrangement permits of much closer readings than are possible on the ordinary slide rule, due to the fact that the total length of the logarithmic scale on the lower table in the device is 110 inches. The method of graduating also differs to some extent from that of the ordinary slide rule, and it is possible by means of the device to multiply three factors at one setting as well as to carry out two divisions at once. This feature of being able to multiply three numbers at once is unique, and the only drawback of the instrument is that it is somewhat difficult to work the upper scale on the lower, there

ordinary cast manganese steel rails used by that company had a life fifty times that of the ordinary Bessemer rails on curves and in other difficult situations. The rolled rails show a uniform structure throughout when fractured, whereas the cast rails have a spongy head and coarse grain. Test bars forged from the head give a tensile strength of 150,000 pounds to 159,000 pounds per square inch, with 50 to 60 per cent elongation in 8 inches.

In the illustration showing rolled Manard manganese rails, A is a 100-pound 33-foot rail of the 1909 Pennsylvania Railroad standard section; B is an 85-pound rail American Society of Civil Engineers standard section twisted cold until six twists remained as a permanent set in 26-foot length; C is an American Society of Civil Engineers standard section with ten 1 1/16-inch holes in the web, bent on the drop testing machine. The total work done represents a dynamic force of about 45,000 foot-pounds, and the rail showed no signs of failure after the bending. D is a 100-pound A. S. of C. E. standard section bent on a drop testing machine, the work done representing a dynamic force equal to 150,000 foot-pounds. E is a 90-pound A. S. of C. E. standard section bent on a drop testing machine and later bent into a U shape under the hammer. All of this bending, of course, was done cold.

The manganese rolled rails cannot be machined with ordinary appliances, but are readily bent to any desired curve with ordinary trackmen's curving tools. They are not magnetic, and the electrical resistance is about 3.4 times that of the ordinary Bessemer steel rails of the same section. The increased resistance, however, does not interfere with track signals in which the track forms part of the circuit.

THREE-FLUTED DRILLS

R. S. F.

Three-fluted reaming drills have been manufactured for a long time by the tool makers of this country. Their common name is "three-fluted drill," and they are so termed in the various catalogues advertising them. The catalogues also note, generally in small type, that these drills will not drill the initial hole. Therefore extensive users have annexed the word "reaming," calling them "three-fluted reaming drills," which impresses upon the workman at once the purpose of the tool. The use of the tool to which the writer desires to draw particular attention is in structural steel work. Therefore, in order to more fully appreciate the class of ma-
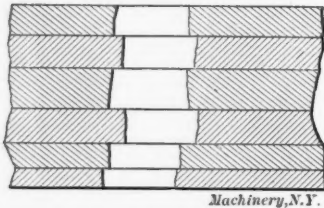
Fig. 1. Several Thicknesses of Structural Steel with Punched Holes, which the Reamer Drill "lines up"

terial on which the tool is used, the reader should be acquainted with some of its irregularities. For instance, the so-called structural steel, such as shapes, plates, bars, etc., in most specifications call for 55,000 to 60,000 pounds tensile strength per square inch with 25 per cent elongation, and it is not only an occasional, but an everyday occurrence, for bars to test as low as 40,000, and as high as 90,000 pounds per square inch tensile strength, with elongations of only 15 per cent and as much as 40 per cent. In fact, in plain words, some material is as soft as iron and some as hard as tool steel.

The specifications also state that all material ⅝ inch thick and above shall be sub-punched 3/16 inch smaller in diameter than the finished hole and reamed to size. Material under ⅝ inch thick is punched full size, and when assembled, this work is easily reamed by the ordinary taper bridge reamer, as there is no material to remove, it merely being necessary to "straighten up the hole" produced by irregular punching.

On the other hand, the sub-punched work (as it is termed in structural shops) is built-up girders, chords, etc., and their thickness varies according to the number of plates, angles, etc., used, being generally from 2½ to 6½ or 7 inches thick, very few being much heavier. When assembled, the punched holes rarely "line up," but usually present an appearance similar to that in Fig. 1. A glance will show that the drill has difficulty in cutting its way through, though very few cases occur where the holes are not "trued up" or nearly so. The average number of reamed inches for high-speed drills for a year's run on this class of work with unskilled
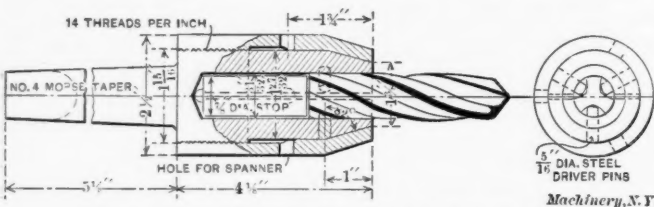

Fig. 2. Chuck for Holding Drills with Broken-off Shanks

labor is 7,500 per drill, breakage being the cause of 75 per cent of the loss on account of the difficulties mentioned.

The reader should not draw the conclusion at this point that faulty workmanship causes all bad punching; in some cases it does, but a large part is attributed to stretch in material. It is necessary to use the same templet on various thicknesses of material, and as each thickness has a corresponding amount of stretch, the drill must straighten up all inaccuracies.

The three-fluted reaming drills, when made of carbon steel, are practically useless in these days of "speed," the average life of a drill being less than 1,000 reamed inches. A chuck, as shown in Fig. 2, is well adapted for using drills after their shanks are broken off, in cases where the thickness of material will allow the use of a short drill.

The foregoing will give the reader a good idea why the high speed three-fluted reaming drill has been adopted, and the following costs of manufacture, compared with the best price for which they can be bought, will explain why some users make their own drills.

COST OF 15-16-INCH THREE-FLUTED REAMING DRILL

	Morse Taper Shank, Over-all Length, 12 inches		Graham Shank, Over-all Length, 10 inches
Turning	$0.18		$0.09
Fluting	0.063		0.063
Milling Tang	0.008	Groove Milling	0.012
Grinding	0.043		0.043
Total shop cost	$0.294		$0.208
Proportion of gen. shop expenses	0.277		0.182
	0.571		0.390
Hardening	0.065		0.065
Material	1.764		1.50
Total cost	$2.40		$1.955

Two inches less material is required for the Graham shank than the Morse taper shank, when both drills have standard length of flute.

The best price known to the writer, previous to the late business depression, for a 15/16 inch drill was $3.90 net. This has been reduced to about $3.15 within the past few months, still leaving a large saving for the user. The above costs are not caused by any special machinery whatever, with the exception of a device fitted to the table of a No. 4 Cincinnati universal milling machine for fluting and backing off.

The accompanying half-tone illustrations illustrate twelve milling cutters on one arbor, six fluting and six backing off. They are placed in pairs, with a separating bushing between, thereby milling six drills at one time. The cutters are all made of high-speed steel and are kept cool by numerous streams of oil supplied by a 1-inch Gould's rotary pump. It requires two 1-inch flexible steel hose to carry the used oil back to the pump. A feed of 0.016 inch per revolution is used. The shape of the cutters for milling a 7½-inch lead, with the table set at 27 degrees, and a half section of the finished 15/16 inch drill is shown in Fig. 3. As all are formed cutters, there are no variations in the flutes caused by the re-grind-
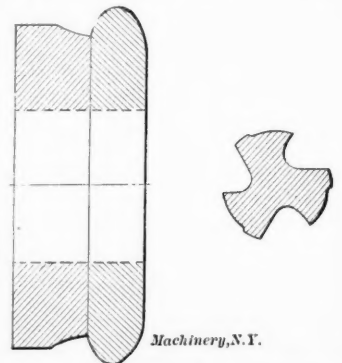

Fig. 3. Fluting Cutter and Section of 15-16-inch Reamer-drill

ing. The depth of the backed-off part will be noticed. It is so milled that after hardening, the grinding is a simple operation, the drills being only ground to their exact size with a taper of 0.010 inch in six inches, the size decreasing toward the shank.

Ordinary methods of hardening have proved superior to all the fancy ones; the fluted part is heated to a bright yellow and permitted to cool in the open air, laid horizontally upon two suspended ½-inch thick square rods, thereby allowing the air to come in contact with all sides. Some makers claim success by cooling in air blast, then drawing in oil, and various other methods; but after having used all the principal makes, the writer has found the above mentioned method superior to them all, especially when performed in the winter months.

Evidence to substantiate the above statement has been acquired from tests made on a large number of various kinds of drills of different brands of high-speed steel. A recent prolonged test proved that drills made of "Blue Chip" steel by the above method out-class all other brands and even excel drills made of the same steel by a certain manufacturer of high-speed steel and small tools.

These tests serve to bring out another phase of the subject, namely: that the best cutting high-speed steel, that is, one that will carry off the greatest amount of heat, does not make the best drills. For example, "Novo" steel will stand a higher speed than any brand known to the writer, but when it is subjected to shocks, such as a twist drill is likely to receive, it generally breaks, and the drill is ruined. Only recently 1 9/16 and 1 7/8 inch diameter drills given to the

writer were split the entire length and yet showed no trace whatever of flaw or crack in the steel.

The "Blue Chip" steel drills are much tougher, and successfully accomplish a very large percentage of the work just described. A 15/16 inch diameter three-flute reaming drill made of this steel has made a record with us of 28,000 reamed inches, only 1½ inch of the drill being used up. Frequently these drills have been twisted a half turn backward in the flutes without breaking. The steel, in its annealed state, is easily worked, a reduction of only about 15 per cent of the speed of machine tools being required below that used on good carbon steel. It straightens easily either in the bar or drill length.
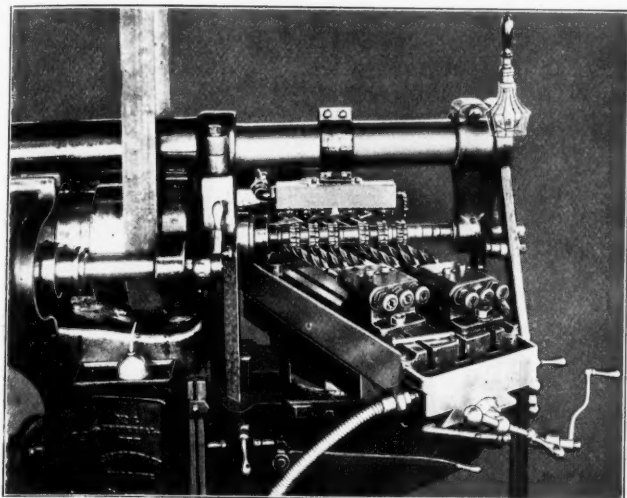
Fig. 4. Fluting and Relieving Six Drills simultaneously

A Warner & Swasey two-inch turret lathe is used for turning, and a maximum cutting speed cannot be obtained for one reason, viz.: the heat generated by the length of the bar against the back-rest is so great that the bar burns fast to the back-rest, despite the continuous flow of oil on that part, therefore the necessity for reducing speed. The roller back rest was brought out to overccme this difficulty, but it does not, for two reasons: First, the rake for the tool recommended by the makers turns a chip like a ribbon and this ribbon-like chip becomes tangled in the turret and
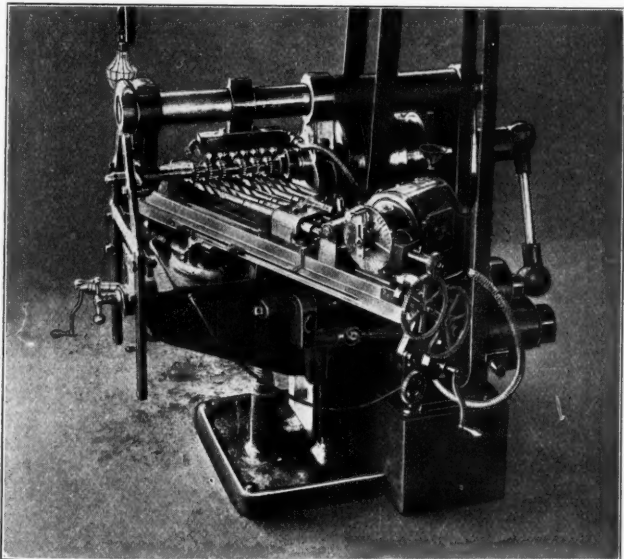
Fig. 5. Multiple Indexing Head used when Fluting and Relieving Drills

among the other tools and thus is a great nuisance and time-consumer. Second, a tool ground to cut an ordinary curled chip works satisfactorily, except that the rollers pull the chips in between themselves and the work, resulting in numerous "digs" in the length of the cut. The Cincinnati No. 4 universal milling machine for fluting the drills works excellently, though taxed to its limit with twelve cutters working simultaneously. A Brown & Sharpe universal grinder, which has an automatic reversing feed, is used for grinding. This machine enables the operator to produce a large quantity of duplicate work at a low labor cost.

BEARING FOR HIGH-SPEED SHAFTS

In bearings for rapidly-rotating shafts such as are employed in steam turbines, high-speed engines, etc., the surface of the bearing structure is often not of sufficient extent to keep the bearing cool by the radiation therefrom of the heat generated by the friction of the bearing surfaces. In order to maintain the temperature of the bearing within safe and proper limits, cooling mediums are circulated over the radiating surfaces to absorb and remove the heat. A method of cooling such bearings by circulating the lubricant for the bearing surfaces through the body of the bearing was illustrated and described in a recent issue of the *Mechanical Engineer*. This bearing, which is the invention of the Vereinigte Dampfturbinen-Gesellschaft mit Beschränkter Haftung, of Friedrich Karl-Ufer 2—4, Berlin, results, it is claimed, in the effective control of the temperature and is attended with many other incidental advantages.

The shaft A rotates in a shell B which is supported by a seat C formed in the bearing frame D, and a cap E which is secured to the frame and holds the shell in place. The seat C is circular in cross-section, and the outer surface of the shell is of similar shape. The shell B is made in two parts by dividing it in a horizontal plane extending through the axis of the shaft, and it is provided with a number of external flanges F which support it on the seat C and assist in the radiation of of the heat imparted to the relatively thin body portion G of the shell by the friction between the shaft and its bearing surface. The outer edges of the circular flanges are in contact with the surface of the seat, thus forming a conduit be-

Fig.1   Fig.2

Machinery,N.Y.
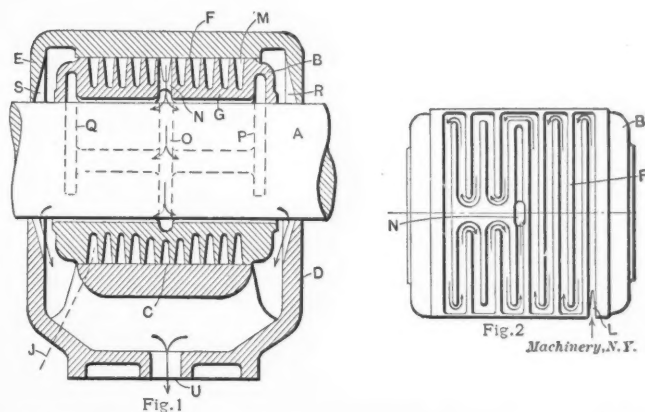
A High-speed Bearing in which the Lubricant is used as a Cooling Medium

tween the flanges and the surface. By suitably arranging the flanges, this channel or conduit is made to follow a winding or tortuous path through or over the shell. The outline of this path may be that of a helix, or it may have a zig-zag shape or the form shown in the illustration, the object being merely to secure a circulation of the cooling medium over a sufficiently large radiating surface formed by the walls of the conduit so that the heat due to friction will be effectively removed. Lubricant is supplied to the conduit J, whence it flows back and forth over the radiating surfaces of the shell and is delivered by the passage L (Fig. 2) to the conduit M in the upper half of the shell. This conduit directs it back and forth over the radiating surface in the manner indicated, and delivers it to the passage N and to the bearing surfaces. Grcoves, O, P, Q, assist in the distribution of the lubricant over the bearing surfaces, after which it escapes into chambers R and S and then flows downward into the chamber in the lower part of the frame. A conduit U drains it from the bearing and returns it to the source of supply for repeated use. Before the oil is delivered to the bearing surfaces, its temperature is raised by the heat which it removes from the bearing in the cooling operation. The lubricating effect of the oil is, it is claimed, increased by this pre-heating, warm oil being a better lubricant than cold oil, so that the friction of the bearing surface is decreased, resulting in a superior operation of the bearing and a reduction in the amount of heat removed by the oil. The result of the decrease in friction and amount of heat generated is that a given bearing may be made to carry a much heavier load without overheating.

MACHINERY

JUNE, 1909

A FACTOR IN GRINDING

To those familiar with cylindrical grinding, it is well known that increasing the work speed increases the wheel wear. In case a wheel is too hard for the work, it is a common expedient to increase the work speed until the wheel cuts satisfactorily. An emery wheel cannot grind freely unless it wears itself away so as to present constantly new cutting points to the work; consequently, increasing the work speed causes the hard wheel to cut more freely because it wears away more rapidly.

The reason for increased wheel wear because of higher work speed is not clear to many who have studied the question, and the first deduction is likely to be that increase of wheel wear because of greater work speed is simply due to more work being done per minute. While this is a reason, it is not the only one, because experience has shown that increasing the work speed will increase the wheel wear *for the same amount of material removed.* Why is this so?

We believe the answer involves a matter of grinding wheel mechanics that apparently has not been given much attention by grinding machine authorities. A particle of emery embedded in the bond of a wheel is held quite insecurely. This can be demonstrated by attacking the face of the wheel, while stationary, with a metal tool. It is an easy matter to scrape off particles of emery, and under this test the wheel appears to be a fragile thing when we consider what it is capable of accomplishing. The common method of testing wheels for grade is to dig into them with a pointed tool, and experts can quickly determine the relative hardness of wheels, or rather the strength of bond in this manner.

Now, what enables the emery to cut when held so insecurely? Largely because of its kinetic energy. The condition is similar to that which gives a rifle bullet its power. A Spitzer bullet weighing 150 grains is projected from a modern Springfield rifle with such velocity that it has a striking energy of 2,400 foot-pounds, 50 feet from the muzzle. It is almost inconceivable that so small a piece of metal can develop such great striking energy, and the fact gives one a vivid conception of the effect of velocity. In less degree, the cutting power of an emery wheel point depends on its velocity.

The standard velocity for grinding machine wheels is about 6,000 feet per minute or, say, 100 feet per second. A particle of emery weighing one grain, embedded in the circumference of a wheel running at the standard speed, has a kinetic energy of $E = Wv^2 \div 2g = 154$ foot-grains, nearly. That is, a particle of emery, because of its velocity, has a kinetic energy equal to 154 times its weight, falling one foot. This kinetic energy enables the point to plow its way through the opposing metal without throwing heavy stress on the bond holding it in place.

The contact of the grinding wheel with the work cylinder is theoretically on a line parallel with the axes, but actually on a surface. A particle of emery is in contact with the work for a period that depends on its speed and the work speed. Suppose that the work were standing still. It is obvious that the grinding wheel will instantly lose its contact with the work, as it will grind an arc into the metal and no longer touch it, but by the constant rotation of the work, new metal is brought into contact with the wheel and removed. During the period of contact the cutting points of emery plow narrow grooves through the metal, the length of each furrow depending on the work speed. If the work speed is doubled, obviously the length of the furrow is doubled. The possibility of an emery point cutting its way through the opposing metal depends upon how much material is opposed to it. The emery points do not act as a mass, but individually and as such have the weakness of scattered fighting units, which, as every soldier knows, can be easily defeated "in detail." There is a near balance existing between the force required to remove the opposing metal, the kinetic energy of the emery points and the centrifugal force tending to throw the loose particles on the wheel face off on a tangent. When the work speed is increased, this balance is lost and a new condition set up which causes the particles of emery to be more rapidly disrupted and new and fresh grinding points will be brought into action resulting in freer cutting.

* * *

BLIND ACCEPTANCE OF AUTHORITIES

It is important for a young engineer to avoid the blind acceptance of authorities, so common in the college-bred youth. The young man fresh from college usually enters practical life with but a vague understanding of many conditions that are deciding factors in constructive engineering work, and he is likely to believe that the formulas and rules laid down by the writers of his text-books may be relied on to give satisfactory results in all cases. He does not doubt the authority of those who wrote the text-books or deduced the formulas, and when he finds that the practical engineer sometimes accepts solutions which appear to be contrary to the rules laid down by his "authorities," he immediately concludes that the men under whom he is working are wrong. Someone has said, with a great deal of truth, that the college-bred engineer is really the best engineer in the long run, if he only is given time to unlearn what he has been taught in college. Of course, this expression must not be taken literally, but there is no doubt that there are many conceptions in the young college engineer, due to his education, which must be modified and sometimes discarded before he can make a success in practical engineering. This is not a reflection on college training and education, but merely implies that it is impossible to take into consideration in the limited scope of a technical college education all the practical factors, limitations and requirements, which enter into almost every engineering problem. In general, the training of the engineering school includes principles only, and the young man who enters into practical occupations must learn that while the principles always hold true, it is seldom that any one principle can be applied, by itself alone, to the solution of a problem. There may be a dozen fundamental principles, each of which enters into the problem; and it is impracticable to lay down a rule exactly determining to what extent each has an application to the problem.

The greatest asset of the engineer is *judgment* and *common sense,* guided by a fundamental knowledge of first principles; and the successful engineer is the man who fully realizes the value of his own judgment, and therefore dares to disregard, to a certain extent, the dictum of authorities, and rely upon his own investigations and experience.

ENTERTAINMENT FEATURES OF THE A. S. M. E. CONVENTIONS

A delightful feature of the semi-annual conventions of the American Society of Mechanical Engineers is the various excursions to points of interest in and about the cities where the conventions are held. The parties going on these excursions are given special attention, and unusual courtesies often are extended in honor of the society. To the ladies and other guests of the members such excursions are particularly enjoyable because of their novelty, and we fear that the majority of the members are more interested in them than in the regular proceedings.

Notwithstanding the popularity of such diversions, we are inclined to question the advisability of featuring them to the extent that has been the case in the last few years. It seems that the prestige of the society will suffer if the entertainment side of the convention is magnified so that it eclipses the technical side. We believe that the society will gain in prestige if less attention is given to pleasure, and more to the real business for which the conventions are intended. Let the Spring conventions be held in places where ample hotel accommodations are provided, but where the outside attractions are minimized. Then the attention of the visiting members will be centered on the papers and discussions. The chief value of the conventions lies in the oral and written discussion of the papers, and in the making of acquaintances and the renewal of friendly relations. If the discussions fail, there is comparatively little profit in traveling hundreds of miles to hear papers read, as every member receives the monthly journal of the society containing them. Let us continue to have entertainments, by all means; but let them be subordinate to the real business of the society.

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THE SHOP OPERATION SHEET ON GRINDING DRILLS

We call special attention to the shop operations in another part of this number, describing the hand grinding of flat and twist drills. We believe they are of such a practical character as to command the attention of every machinist, foreman and superintendent of machine work, particularly if they are concerned with the instruction of apprentices and others.

The drill is the most used metal cutting tool, and receives the most abuse. Common laborers often are put to work on drill presses and required to keep their drills sharpened. When proper instruction in grinding is not given, the results are deplorable; power is wasted, drills are broken and rapidly worn out, and holes produced larger than the desired sizes, all of which could be avoided by giving practical lessons in drill grinding at the start. It is comparatively easy to grind a flat or twist drill by hand to a fair approximation of the correct shape if the proper shape is known to begin with, but that is just what many otherwise good mechanics do not know. A study of the operation sheet by those who *do* know, undoubtedly will give them a better understanding of the matter and better fit them for instructing those in their charge in the matter of upkeep, that is sadly neglected in many shops. A drill grinder is a tool whose value is not properly appreciated, and until it is a common part of machine equipment, hand grinding will be a matter for every machine man to understand.

* * *

THE MECHANICAL ENGINEER IN PUBLIC RELATIONS

An amendment to the constitution of the American Society of Mechanical Engineers was offered at the Washington meeting, which provides for a committee on public relations. It is the belief of a number of the members prominent in the society's affairs that the influence of the mechanical engineer on civic matters should be made much greater than it now is. In these days of machinery and great mechanical engineering works, the advice of the mechanical engineer on matters of public importance is not sought by the heads of municipalities and civic authorities as much as it should be. It is the aim of those standing sponsors to this movement for pub-

lic relations to bring about a realizing sense of the value of the advice of the mechanical engineer in projects affecting the general welfare of communities. The paper "The Engineer and the People," read by Mr. Morris Llewellyn Cooke at the December, 1908, meeting of the society, called the society's attention to the importance of closer relationship between mechanical engineers and the national and municipal governments, and doubtless the proposed amendment to the constitution was inspired by it.

The movement is one that we heartily endorse; and any other movement that will tend to place the mechanical engineer and his worthy assistant, the machinist, in a position commanding greater respect of those benefited by their work, will receive our commendation. We feel that the mechanical work that has been largely instrumental in placing this country among the foremost nations of the world, has not been properly appreciated by the majority of those who have benefited thereby. The age of the politician is passing away, and following it is the age in which the achievements of the business man and the mechanical engineer will receive national recognition. Let us bring into prominence the work of our engineers, and stimulate in the minds of the younger generation the desire to emulate the constructive work of these men, which means so much more for the world's welfare than does politics, diplomacy or war.

* * *

THE NEWER HIGH-SPEED STEELS

O. M. BECKER*

After the metal cutting industries had taken breath, so to speak, following the advent of air-hardening or high-speed steels, and begun to adjust themselves to the new situation, the use of self-hardening or mushet steels rapidly decreased until very little call for it existed and most manufacturers ceased making it altogether, putting out instead a more or less excellent quality of the high-speed kind. This, however, was not for some little time after the Taylor-White discoveries became public. The self-hardening steels had come into rather general use in difficult jobs, and in progressively managed shops were used to a considerable extent on all sorts of jobs; and so, while the new steels with their wonderful possibilities were justifying themselves and establishing their place, very properly there was a disposition to hold fast to that which had already proved itself, rather than to take up something but little known or tried. Recently there has again come to be some demand for steels which, while possessing the qualities of high-speed steel to a moderate degree, enough to adapt them to a class of work not requiring its high cutting powers and red-hardness, could be bought at a price considerably below that of high-grade air-hardening steel; and a number of manufacturers have brought forward steels to fill this gap. There doubtless are many kinds of work wherein a steel of less endurance than the best high-speed varieties would answer every requirement and yield results equally as good—jobs where extremely high speeds or heavy cuts are in the nature of the case impracticable, or as in certain woodworking operations, where a cutter of higher endurance than one of the best carbon steel would have an almost indefinite life anyway. In such cases, it would seem, the high cost of air-hardening steel imposes an unnecessary expense in tool equipment.

Most such "new" steels are nothing more nor less than mushet or self-hardening, though some seem to be manganese rather than tungsten steels. A typical example of such a "special," "intermediate," or "semi-high-speed" steel, of excellent sustaining power and not exceptionally hard to treat, has the composition:

Carbon	1.190 per cent.
Tungsten	7.560 per cent.
Chromium	3.340 per cent.
Manganese	0.460 per cent.
Phosphorus	0.024 per cent.
Sulphur	0.025 per cent.
Silicon	0.200 per cent.

Another, corresponding still more closely in its composition to mushet steel, gave this analysis:

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Carbon	0.94	per cent.
Tungsten	4.78	per cent.
Chromium	0.69	per cent.
Manganese	0.27	per cent.
Phosphorus	0.01	per cent.
Sulphur	0.01	per cent.
Silicon	0.11	per cent.

Both these steels, it will be observed, are rather lower in carbon than most mushet steels formerly were, and the first is rather higher in tungsten while the second is lower in chromium. A third, which scarcely falls within the mushet class, is thus composed:

Carbon	1.25	per cent.
Tungsten	2.25	per cent.
Chromium	0.28	per cent.
Manganese	0.85	per cent.
Silicon	0.21	per cent.

The latter is advertised and sold specifically as a "finishing" steel; and it unquestionably gives excellent results in this particular kind of work. There are, besides, a number of other steels on the market, sold for tool use, whose tungsten content (or molybdenum equivalent) ranges anywhere below that essential to a high grade high-speed steel—say 17 per cent —and down to that indicated in the analyses above. Most of these are sold as high-speed steels, though usually at a lower price than is customary for those of highest grade, and to a greater or less extent are so, when the chromium content corresponds with the tungsten.

Still another steel very widely advertised as an "intermediate" steel, and certainly working exceedingly well in certain classes of work, including blanking and stamping as well as cutting wood and metals of moderate hardness, has this anomalous composition:

Carbon	1.03	per cent.
Tungsten	0.46	per cent.
Chromium	0.00	per cent.
Manganese	0.30	per cent.
Phosphorus	0.025	per cent.
Sulphur	0.009	per cent.
Silicon	0.008	per cent.

This is represented as a very dense steel requiring very slow and careful heating to a bright cherry red (800 to 850 degrees C. or about 1,500 to 1,550 degrees F.) for cutting tools, and somewhat lower for tools intended to withstand pressure or blows. It is water hardening, as might be supposed from its composition, and requires the temper to be drawn, as in the case of carbon steel tools. It is claimed to be at least 50 per cent tougher than carbon tool steel—though that is about what it seems really to be except for being high in manganese. Several other steels sold for about the same purposes also have about the same manganese, and some a good bit higher.

The most recent development in tool steels seems to be quite as startling as was the announcement of the Taylor-White process and the advent of high-speed steels. If the preliminary experiences with these remarkable steels can be maintained, as there seems to be no reason to doubt, another long step has been taken in tool steel development. For some time, perhaps as long as two years preceding this writing, it has been known to the informed that in certain steel works tools were in use very greatly superior to those made from steels regularly upon the market, tools capable of cutting at greatly superior speeds and maintaining themselves much longer in good cutting condition than is customary with ordinary high-speed tools. Experiments had been going on, apparently in a number of places at the same time, looking to the production of a superior steel which would free the makers from the limitations imposed by the Taylor-White patents, should the litigation relative to them terminate favorably to the holders of the patents. The results have been startling indeed.

It is possible, without any question, to cut at speeds double those possible with ordinary high-speed steels, and even much higher, the tools standing up to such astonishing speeds as five hundred feet per minute under good condition, it is reported. The greatest advantage, however, lies not so much in the increased cutting speeds as in the very greatly superior lasting quality. A tool of the new high-speed steel can be made to last as much longer than one of the best kind previously made, as that will outlast one of carbon steel. The most refractory metals can be cut with ease. Chilled iron, which could be cut with ordinary high-speed steel with difficulty, that is to say, at speeds near ten feet per minute and then only with very frequent grindings of the tool, can now be machined with comparative ease. Hard spots in skidded tires, to mention another example of the possibilities, which were likely to play havoc with the very best of tools, are cut through with little or no sign of their presence. Chilled rolls which the best tools previously available would scarcely touch, have been turned at 80 feet per minute. In hard material particularly do these newest steels show their powers to the best advantage. In softer metals, as in low carbon steels, there is a possible gain ranging from 25 to 60 per cent over ordinary high-speed tools, in regular work; though the makers seem to prefer to recommend in general that there be no distinctive increases in cutting speeds on this class of work.

The lasting qualities of these steels is astonishing, compared with ordinary high-speed steels even. Tools last from two to eight times as long before requiring re-grinding, depending upon conditions, the greatest advantage apparently being in the case of cutting very hard materials. The tool will cut without any diminution of its powers, apparently, while the nose is glowing at a bright red. Evidently the temperature points at which red-hardness or tempering begins is considerably higher than that of ordinary high-speed steels.

Following the first announcement of the new or superior high-speed steels, few details concerning them were obtainable, the makers preferring to keep their secret for the time being. The steels are now sold upon the open market, and it can be stated that in details of working up into tools they do not differ in any essential particular from the ordinary high-speed steels. It is true they can be hardened in salt water; and it is reported that this has been done in the case of a particular tool a great many successive times without any cracks developing. Nevertheless even the makers admit that cracking is likely to take place, hardening in air or oil being the preferred and recommended method. For cutting exceedingly hard materials, like chilled iron, the water hardening is recommended, in spite of the possibility of cracking.

The new steels are easily forged, though the forging heat is best kept rather higher than is usual with the other high-speed steels, say at a yellow, or at the least at a bright red. The heat must on no account be lower than the latter, say not far from 950 degrees C. or 1,750 F. Annealing is done easily and simply, and it is declared that there is no possible danger from overheating in hardening.

The cost of the new steels is considerably higher than that of the ordinary high-speed kinds, so that its use in preference to the latter must be justified by exceptional conditions, such as especially difficult materials to cut, or the possibility of great economies. The latter arise, as already mentioned, less from increased speeds than from superior lasting qualities. The consumption of tool steel results from grinding the tools and the final rejection of the tool stock as too small for proper use. Evidently if a tool can run four to eight times as long without grinding (and give a superior finish at the same time) as the best previously available, this saving in steel and in time lost changing tools would go a long way toward justifying its use, even at double the cost.

* * *

If a delicate piece of machinery can not be adequately protected from rough handling by the operator, it is better to leave the parts exposed and let his own judgment dictate the usage to which the parts should be subjected. An example illustrating the idea is the method employed in packing high grade glassware, especially cut glass that is very costly. A plan which has been followed with success is to pack it in barrels with excelsior, filling the barrel full and exposing a piece of the glass at the top. That exposed piece is the danger signal and a freight handler must have considerable hardihood who will treat that barrel disrespectfully. He knows that he cannot turn the barrel over on its side, and the exposed glass effectually prevents piling other freight on top.

NEW ENGLISH VERTICAL MILLING MACHINES

FRANK C. PERKINS*

The accompanying illustrations show the construction of four milling machines designed and constructed at the Manchester Works of Sir W. G. Armstrong Whitworth & Company. Fig. 1 shows a small, sensitive, vertical milling machine driven by an electric motor and designed chiefly for use on the breech mechanism of guns. The base plate, it will be seen, is arranged as a tank into which the lubricating oil runs and from which the oil is pumped through pipes to the milling tool. This machine is driven by a variable-speed motor and is suitable for high-speed work. It will be noted that it consist of a box pattern frame with square slides to receive the knee. The machine is fitted with a steel spindle running in a tube having adjustment vertically by a hand-wheel, worm
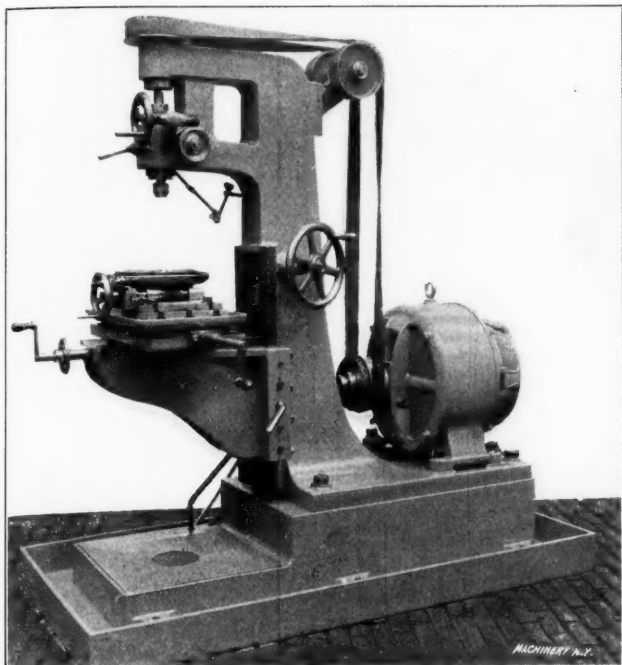
Fig. 1. Electrically-driven Sensitive, Vertical Milling Machine, built by Sir W. G. Armstrong-Whitworth & Co.

gear, and rack and pinion. The spindle is locked in any position by the lever seen just below and to the left of the hand-wheel, and it is arranged with conical bearings, the thrust being taken by ball bearings, while the upper end is supported in a bushing running in a bronze bearing. A variable-
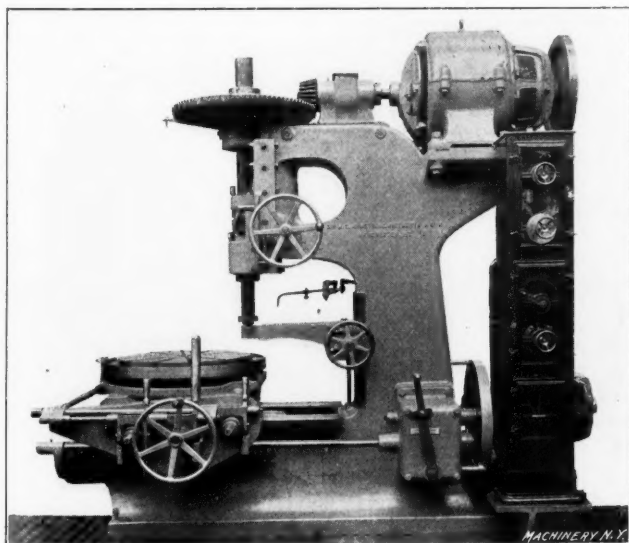
Fig. 2. Vertical Milling Machine with Two Motors—One for the Main Drive and the other for Operating the Feeds and Quick Traverse

speed motor is used for driving, as mentioned; it is directly connected to the base of the upright and drives by belt over guide pulleys to the pulley on the top of the machine. The longitudinal traverse of the table is 10 inches, and the transverse movement 18 inches. The vertical adjustment of the

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table is 18 inches, and the vertical adjustment of the spindle, 2 inches.

The electrically-driven vertical milling machine seen in Fig. 2 is operated by two electric motors. One of these is mounted on the top of the upright and is used for the main
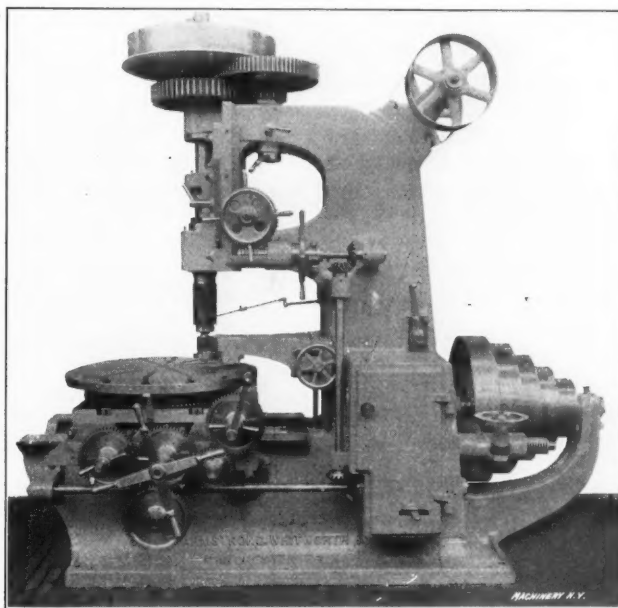

Fig. 3. Belt-driven Profiling and Vertical Milling Machine

drive through bevel gears, while the other motor is fitted to the back of the upright at the base, for the feeds and quick traverse. The machine has longitudinal, transverse and circular feeds, all of which can be automatically tripped. The main motor on the top of the upright has a variable speed
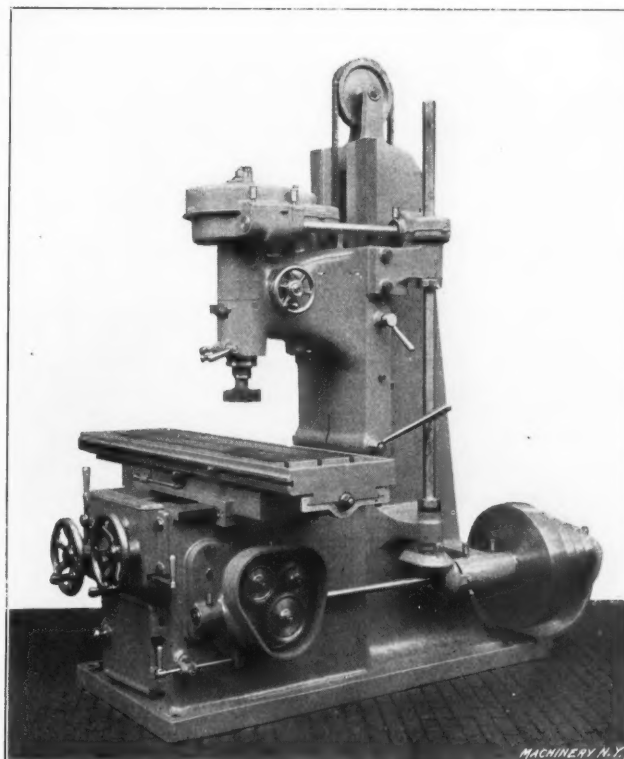

Fig. 4. Vertical Milling Machine designed for a Wide Range of Work

which gives the necessary spindle speeds. It may be stated that one of the features of this vertical milling machine is that the feeds can be thrown in or out of gear by means of clutches worked by levers, which are always in a convenient position, as they do not revolve with the feed-screws as do the handles of the machine shown in Fig. 3; consequently the feeds can be easily thrown in or out of gear. The electric controlling panel seen at the right in illustration Fig. 2 is of special interest. This panel contains a starting switch for the two motors, and a regulating switch for the main drive motor as well as a regulating switch for the feed motor.

It is also provided with electric circuit breakers, which are so arranged that it is not possible for one motor to run while the other is stopped. On this machine there is a vertical hand feed to the spindle for adjustment. The machine was designed for locomotive work and has a capacity for removing 6 cubic inches of material per minute.

The profiling and vertical milling machine seen in Fig. 3 is belt-driven from a counter-shaft, and is fitted with a cone pulley at the back and an endless belt which passes over the top of idler pulleys on the column. All the feed gear is contained in a box seen attached to the side of the column, and the various speeds can be connected by means of the hand wheel, rack, and pinion shown to the rear of the feed-box. The lever seen just above the box reverses all feeds. A machine which is adapted to a great variety of work and which is also constructed at the Manchester works, may be seen in Fig. 4. This machine has a solid base. The milling head is fitted with an adjustment for position, while the feed of the spindle is controlled by means of a small hand-wheel on the head. It will be noted that all of the motions of this machine are controlled by handles from the front, which is a great convenience.

* * *

WASHINGTON MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The regular Spring meeting of the American Society of Mechanical Engineers was held at Washington, May 4 to 7 inclusive, the New Willard hotel being the headquarters. Between 280 and 290 members were registered, and a large number of guests were in attendance. The meeting opened with an address of welcome delivered by Hon. Henry D. F. MacFarland, president of the Board of District Commissioners, and responded to by Jesse M. Smith, president of the society, following which was a reception and dancing in the large auditorium of the hotel on the tenth floor.

On Wednesday afternoon the members and guests attended a special exhibition drill of the United States Army troops at Fort Myer, where the Baldwin dirigible balloon and the Wright aeroplane tests were made last Summer and Fall. The balloon was on view at a remote point and was visited by a few of the members. On Wednesday evening Mr. F. H. Newell, director of the United States Reclamation Service, delivered an illustrated lecture "Home Making in the Arid Regions" which was a very interesting exposition of the great work being done by the United States government in the desert regions of the west.

On Thursday afternoon the members and guests were received by President Taft in the East Room of the White House. On Thursday evening, Rear Admiral George W. Melville, retired, addressed the society on the subject "The Engineer in the Navy." He was followed by Walter M. MacFarland of Pittsburg, Pa., who spoke on Rear Admiral Melville's service to the engineering profession and the nation, following which was the presentation to the National Gallery of a life-size portrait of Admiral Melville by Ivanowski.

On Friday afternoon a boat trip was made to Mount Vernon, the plan being to return to Fort Myer to witness an ascension of the Baldwin dirigible balloon under direction of Lieutenant Lahm. On account of a thunder storm, the ascension was not attempted.

Amendments to the constitution were proposed to section C10 regarding the qualification of associate members of the society, and C45 defining the standing committees, it being proposed that a public relations committee be added. According to the constitution all amendments to the constitution must be proposed at the Spring meeting and acted upon at the Fall meeting.

The following papers were presented:

"A Unique Belt Conveyor," by Ellis C. Soper, Detroit, Mich.

"Automatic Feeders for Handling Material in Bulk," by C. Kemble Baldwin, Chicago, Ill.

"A New Transmission Dynamometer," by Prof. William H. Kenerson, Providence, R. I.

"Polishing Metals for Examination with the Microscope," by Albert Kingsbury, Pittsburg, Pa.

"Marine Producer Gas Power," by C. L. Straub, New York.

"Operation of a Small Producer Gas Power Plant," by C. W. Obert, New York.

"A Method of Improving the Efficiency of Gas Engines," Thomas E. Butterfield, Philadelphia.

"Offsetting Cylinders in Single-Acting Engines," by Professor T. M. Phetteplace, Providence, R. I.

"Small Steam Turbines," by George A. Orrok, New York.

"Tests on Compressed Air Pumping Systems of Oil Wells," by Edmund N. Ivens, New Orleans.

"Safety Valves": Discussion continued from the February meeting in New York.

"Specific Volume of Saturated Steam," by Professor C. H. Peabody, Boston.

"Some Properties of Steam," by Professor R. C. H. Heck, New Brunswick, N. J.

"A New Departure in Flexible Staybolts," by H. B. Wille, Philadelphia.

* * *

FRENCH METALLIC PACKING CONSTRUCTION

The accompanying engraving shows a stuffing box made up of three rings whose bore is several tenths of a millimeter larger than the piston rod. The three rings are so arranged that two of them, one on each side, are pressed upward by means of springs, and the center one downward partly by its
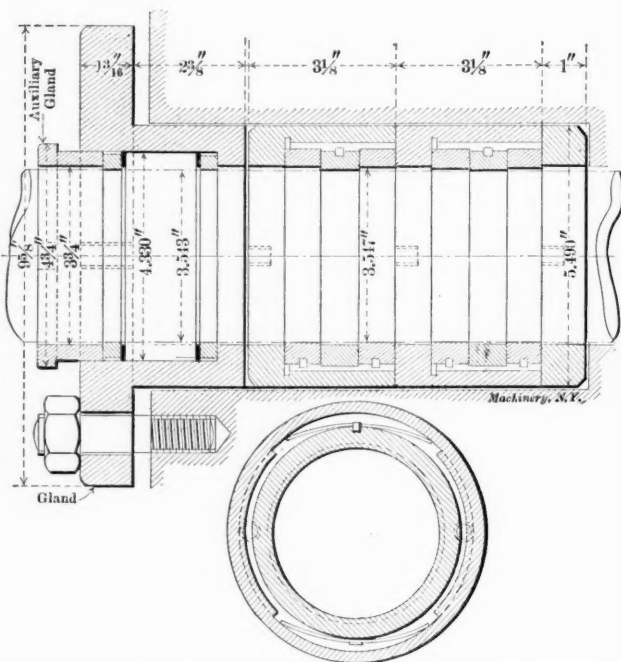
French Metallic Packing Construction

own weight and partly by a spring. By this arrangement, although the rings have play, the steam cannot escape. The rings do not suffer appreciable wear as the springs have a very slight tension. This stuffing box is the design of the Ateliers de Construction H. Bollinckx, Brussels, Belgium.

* * *

Some interesting figures relating to the number of telephones in use in some of the largest cities in the world are given in a recent issue of *Teknisk Tidskrift*. The figures give the number of inhabitants per each telephone and are as follows: Stockholm, 6.6; Chicago, 11.2; New York, 12.5; Berlin, 20.6; Paris, 42.4; London, 46.1. The figures for Stockholm, however, only take account of the number of subscribers of the private telephone company of the city. If the state telephones, owned and operated by the government, are also included, the figure would be about one telephone for every four inhabitants. The reason why telephones are so commonly used in Stockholm is due to the fact that in no city in the world of similar size have the charges for telephone service been brought down to so low a level, making it possible for almost everyone to have a telephone installed in their home. Less than $10 a year pays for a telephone permitting of liberal use without any additional charge, and $22 a year provides for unlimited service within a radius of forty miles.

A NEW TRANSMISSION DYNAMOMETER*

WM. H. KENERSON†

The author has received from time to time many requests for a simple transmission dynamometer, and has himself often felt the need of one which would be more generally applicable than those now in use. These continued requests, together with the requirements of a definite problem whose solution demanded a rigid transmission dynamometer in the form of a coupling, led to the design and construction of the instrument described below. The accompanying illustrations show the construction of the dynamometer and its method of application and use. In Fig. 2 and Fig. 4 the corresponding parts of the dynamometer are given the same letters.

The couplings A and B, each keyed to its respective shaft, are held together loosely by the stud bolts C. The holes in the flange A are larger than the studs C, so that these studs have no part in transmitting power from one shaft to the other. The power is transmitted from A to B through the agency of the latches L, four of which are arranged around the circumference of the flange B. These latches are mounted and are free to turn on the studs E. The two fingers of the latches engage the studs F on the flange A. On the ends of each latch are knife-edges parallel to the stud about

is an actual calibration curve for a small instrument, obtained by hanging standard weights at proper distances from the shaft on a horizontal lever attached to the shaft, and reading the pressures indicated by the gage for the various torques shown in the diagram. For ordinary purposes, however, it is not necessary to calibrate the instrument by actual trial, since computations of the oil pressures for the various torques from the lengths of the lever-arms and diaphragm area check very closely those thus obtained.

It will be seen that the weighing means is similar to that employed in the Emery testing machine, which is recognized as being extremely accurate. It will be possible to employ the Emery flexible steel knife-edges on the levers, if desired, but this has been found in practice an unnecessary refinement.

The construction makes the coupling as nearly rigid as materials will permit, the movement of the diaphragm being extremely small. The only flow of oil through the copper connecting-pipe is that sufficient to alter the shape of the Bourdon tube, if that be the form of gage employed. As soon as the normal position of the gage is reached this flow ceases, hence there can be no fluid friction. It is possible, therefore, to use as long and as small a tube as desired, without intro-
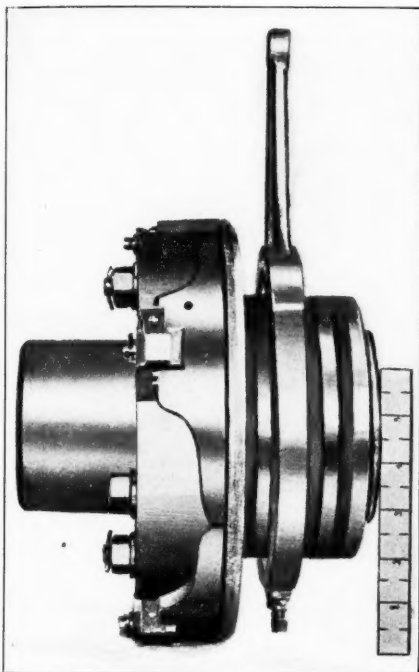

Fig. 2. Transmission Dynamometer taken apart to show Construction

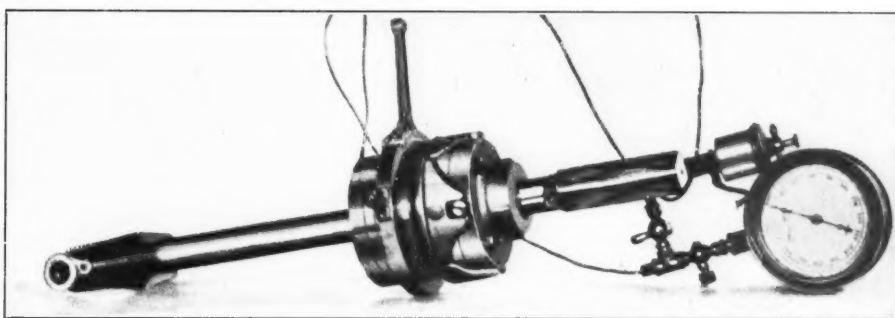
Fig. 1. Dynamometer for 2-inch Shaft, Weight 60 pounds

Fig. 3. Transmission Dynamometer in Automobile Propellor Shaft, 30 H.P. at 500 R. P. M., Weight 25 pounds

which the latch turns. For either direction of rotation of the flange A the latches L, which are in effect double bell-crank levers, will exert a pressure on the disk G, tending to force it axially along the hub cf the coupling B, and this pressure, it will be seen, is proportional to the torque.

Between the end-thrust ball, or roller, bearings M M, is held the stationary ring S, which is the weighing member. O is a thrust-collar screwed on the hub of B, and P is its check nut, which is ordinarily pinned to the hub when in position. The stationary member S, in the form of a ring surrounding the shaft, is prevented from rotating by fastening to some fixed object the attached arm shown in the view (Fig. 1) of the assembled instrument. In this ring is an annular cavity covered by a thin, flexible copper diaphragm D, against which the ball-race of one of the thrust-bearings presses. The edge of this ball-race is slightly chamfered to allow some motion to the diaphragm. The cavity is filled with a fluid, such as oil, and connected by means of a tube to a gage. The oil pressure measured by the gage is proportional to the pressure between the thrust-bearings, which in turn is proportional to the torque.

The instrument may be calibrated in the torsion testing machine or by means of a sensitive friction brake. Fig. 5

ducing error. Where the gage is placed at a distance above or below the coupling, correction should of course be made for the static head.

Other means than the gage shown may be employed to measure the fluid pressure. Where extreme accuracy is desired it will be well to employ the weighing device used with the Emery testing machine. The manograph has been used in this connection to measure variations in torque too rapid for indication by the ordinary gage. For example, the variations in torque in a single revolution of the shaft of a 3-cylinder gasoline engine have been recorded with its aid.

Where the rate of rotation of the shaft is variable and it is desired to indicate the horse-power direct, the combination of gage and tachometer shown in Fig. 6 is employed. The hydraulic gage is connected to the coupling described, its pointer therefore indicating torque. The pointer of the tachometer shows the number of revolutions per minute. Being a function of the revolutions per minute and the torque, the horse-power will be indicated by the intersection of the two pointers and suitable curves on the dial as shown. Arrangements for recording or integrating the work done may also be attached to the coupling.

A summary of some of the more important characteristics of the instrument follows:

a. The instrument is compact. The example shown in Fig. 2 and Fig. 3, which is designed to transmit 30 horse-power at

500 R. P. M., is about 5⅞ inches diameter and weighs about 25 pounds.

b. It is as rigid as an ordinary flange coupling.

c. It may be made in the form of a coupling, and will then occupy about the same space as the usual flange coupling, or it may be made in the form of a quill on which a pulley is mounted. This form may be made in halves for application to a continuous shaft.

d. It will indicate for either direction of rotation of the shaft.

e. The torque may be read and recorded or the work integrated at a considerable distance from the coupling.

f. The readings do not require correction for different speeds of rotation. All parts containing oil are stationary, hence are unaffected by variation in speed. Other parts are likewise unaffected by centrifugal action.

g. It may be made very sensitive and accurate. The construction lends itself very easily to variation of range of application and to varying degrees of sensitiveness, since the oil pressure, and hence the sensitiveness of the instrument, depends upon the area of the diaphragm, the relative lengths of the arms of the latches *L*, and the diameter of flanges. Its accuracy is dependent mainly on the degree of accuracy of the means employed to measure the fluid pressure, of which a number of forms, other than the usual pressure-gage, are available.

h. The only power absorbed is the small amount due to the friction of the ball, or roller, bearings, and this can be deter-

RECLAIMING ARID REGIONS IN THE WEST

The illustrated lecture by F. H. Newell of the Government Reclamation Service, delivered the evening of May 5, at the Washington convention of the American Society of Mechanical Engineers, was one of the most interesting and instructive entertainments provided. The extent of the government's work in reclaiming the arid regions of the West is but dimly appreciated by the majority of people in the east. The work is of vast extent and is being pushed with vigor in Arizona, New Mexico, Colorado, California, Idaho, North Dakota, Washington, Oregon, and other states. The colored views thrown on the screen of the results already realized from this work, vividly impressed all with the wonderful work accomplished which will mean more for future generations than for the present. The fruit produced on irrigated ground surpasses that of any other part of the world, especially the products of the land in the Northwest where the long summer days and fertile soil are extremely favorable to the best development and coloring. The extent of the work from the engineer's point of view, staggers the imagination, even of engineers accustomed to think of big projects. Dams, ditches, sluices, and other hydraulic works have been constructed under conditions of greatest difficulty. In many places special roadways, miles in extent, and along the sides of cliffs and in other trying situations, were necessarily built before the work could be done. The highest dam in the world will be on the Soshone river, in Idaho, its height being
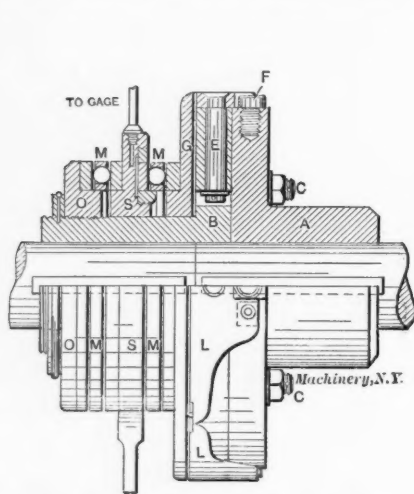

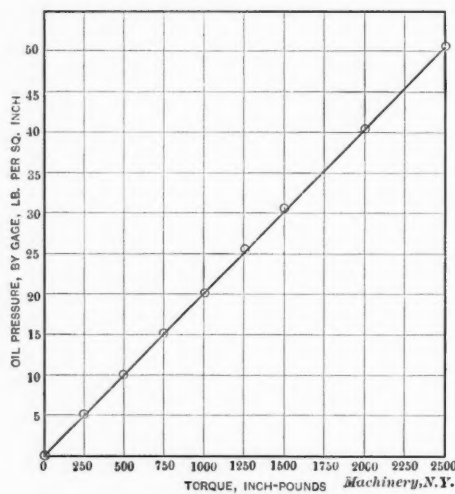Fig. 4. Dynamometer Shown in Section

Fig. 5. Calibration Curve for Transmission Dynamometer
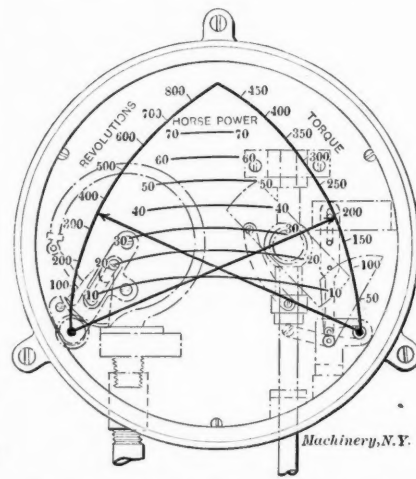

Fig. 6. Combination Pressure Gage and Tachometer, indicating Torque, Revolutions per Minute, and Horse-power

mined from the pull of the retaining arm. It is unnecessary to make correction for this, however, since the amount is so small as to be negligible.

i. Since the only wearing parts are the ball, or roller, bearings, which may be lightly loaded, the instrument should not be deranged easily. Because of the very small volume of oil contained in the weighing chamber, ordinary temperature changes do not affect the calibration. All parts containing oil are stationary, hence all joints may be soldered and leakage entirely prevented.

* * *

A curious condition exists regarding the penetration of high power rifle bullets, the penetration actually being greater at 100 yards than at 50 feet from the muzzle. The official data on the penetration of the Springfield army rifle, model 1903, using the cartridge loaded with 48 to 50 grains of pyrocellulose and the 150-grain Spitzer bullet is 33.5 inches of white pine boards 1 inch thick placed 1 inch apart at 50 feet from the muzzle; 46.7 inches, at 100 yards, and 24.3 inches at 500 yards. The difference is even more marked with thoroughly seasoned oak, the penetration being 12.2 inches at 50 feet and 33.6 inches at 100 yards. This condition of greater penetration at long ranges and reduced velocity is what caused the failure of the so-called bullet-proof cloth invented in Europe several years ago. The cloth or padding did actually arrest high speed bullets fired at close range, but at 300 to 500 yards, it was readily penetrated.

328 feet. In this case the vast body of water impounded will irrigate not only the land below the natural water level, but will also be used to irrigate land considerably above it; the power developed by the dam will be employed in part for pumping water to the higher levels. The development of electric transmission of power enables modern irrigation engineers to accomplish wonders that were impossible before. The power developed by the dams is in many cases large, and through long distance transmission the water from canals or ditches can be elevated at far distant points to levels considerably above the general level of the country and thus new areas are brought under the magic effect of water. A feature of the Western arid lands now under irrigation, not generally appreciated, is its great fertility. Not having been rain soaked for centuries, the mineral constituents of the soil have been retained and when watered, the luxuriant vegetation produced is marvelous.

* * *

An airship of large dimensions is now being built at the Siemens-Schuckert Works in Berlin, Germany. The length of the airship is 426 feet, and the diameter of the supporting balloon is 42½ feet, the volume being about 460,000 cubic feet. The balloon space will be divided up into sections, so that if one part of the balloon is injured, it will still remain in the air. The airship is provided with four 125 H. P. motors, and it is expected that it will have a speed of at least 38 miles (60 kilometers) an hour.

FORMULAS FOR STRENGTH OF FLAT PLATES*

WILLIAM F. FISCHER†

The machine designer is often called upon to carry out designs consisting in part of flat surfaces, such as plates supported or fixed at the edges, with or without intermediate supports or ribs. Exact formulas for finding the bending moments of flat plates, and their resistance to the stresses created by pressures normal to their surface, have not, to the writer's knowledge, been determined. The formulas given by different authorities are founded on assumptions, and
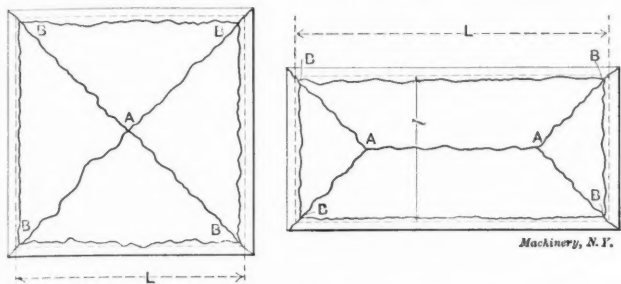
Figs. 1 and 2. Probable Manner of Rupture of Flat Square and Rectangular Plates, held securely at the Edges

should be considered as probable approximations only; they should be used with caution, as the results obtained are not likely to be very accurate. In devising such formulas, all the assumptions should be made to err on the safe side.

Square Plates

A square cast iron plate fixed or rigidly held at the edges and loaded with a uniformly distributed load, or a load con-

supported at all four edges and the load is uniformly distributed over the unsupported surface of the plate. Formulas given by different authorities are reproduced and the various values for total load, unit stress, etc., as obtained from the original formulas given by each authority, are given. A formula deduced by the author of the present article is also included.

In Table II in the Supplement are given formulas for square flat plates secured along all four edges with the load uniformly distributed over the unsupported surface. In the same table formulas are also given for square flat plates loaded at the center.

Rectangular Plates

In Fig. 2 is illustrated the probable manner of failure of a flat rectangular plate of cast iron loaded with a uniformly distributed load. The plate, if uniformly loaded and secured along all the four edges would probably fail by fracturing along the center line $A\,A$ of the longer axis of the plate, and along the diagonal lines $A\,B$, and then fail at or near the edge of the support along the lines $B\,B$. If the plate were merely supported along all four edges, it would fail simply by fracturing along center line $A\,A$ and the diagonal lines $A\,B$. As may be readily seen, the plate firmly secured at the edges offers a much greater resistance to the stress created by the load than does the plate merely supported at the edges.

In Table III in the accompanying Supplement, a number of formulas for flat rectangular plates supported at all four edges and loaded with a uniformly distributed load are given. Among these are also included formulas deduced by the writer. In Table IV are given formulas for flat rectangular

RECTANGULAR FLAT PLATES SUPPORTED AT ALL FOUR EDGES AND LOADED WITH A CENTER LOAD W

Author and Reference	Formulas as Given by Author	Safe Load at Center of Plate $W =$	Unit Stress in Extreme Fiber of Material $f =$	Thickness of Plate in Inches $t =$
Grashof, Trautwines, C. E. Pocket Book, page 493	$f = \dfrac{3\,C\,W\,L\,l}{2\,t^2\,(L^2 + l^2)}$ $C = 2$	$0.34\,\dfrac{f\,t^2\,(L^2 + l^2)}{L\,l}$	$3.\,\dfrac{W\,L\,l}{t^2\,(L^2 + l^2)}$	$1.73\,\sqrt{\dfrac{W\,L\,l}{f\,(L^2 + l^2)}}$
Rankine, Civil Engineering, page 543	$M = \dfrac{3\,W\,L^4\,l}{8\,(L^4 + l^4)}$ where l is less than 1 19 l	$0.45\,\dfrac{f\,t^2\,(L^4 + l^4)}{L^3\,l}$	$2.25\,\dfrac{W\,L^3\,l}{t^2\,(L^4 + l^4)}$	$1.5\,\sqrt{\dfrac{W\,L^3\,l}{f\,(L^4 + l^4)}}$
Rankine, Civil Engineering, page 543	$M = \dfrac{W\,l}{4}$ being the same as for a plate supported at side edges only	$0.67\,\dfrac{f\,L\,t^2}{l}$	$1.5\,\dfrac{W\,l}{L\,t^2}$	$1.225\,\sqrt{\dfrac{W\,l}{f\,L}}$

RECTANGULAR FLAT PLATES, FIRMLY SECURED ALONG ALL FOUR EDGES AND LOADED WITH A CENTER LOAD W

Author and Reference	Formulas as Given by Author	Safe Load at Center of Plate $W =$	Unit Stress in Extreme Fiber of Material $f =$	Thickness of Plate in Inches $t =$
Grashof, Trautwines C. E. Pocket Book, page 493	$f = \dfrac{2\,C\,W\,L\,l}{2\,t^2\,(L^2 + l^2)}$ $C = 1.75$	$0.38\,\dfrac{f\,t^2(L^2 + l^2)}{L\,l}$	$2.62\,\dfrac{W\,L\,l}{t^2\,(L^2 + l^2)}$	$1.6\,\sqrt{\dfrac{W\,L\,l}{f\,(L^2 + l^2)}}$

M = maximum bending moment, inch-pounds
L = long span between supports
l = short span between supports
W, f and t as given above.

Note: Rankine gives bending moment M only as given in second line.

Writer assumes resisting moment M_1 as $M_1 = \dfrac{f\,l\,t^2}{6}$

Then $M = M_1$ or $\dfrac{3\,W\,L^4\,l}{8\,(L^4 + l^4)} = \dfrac{f\,L\,t^2}{6}$; also $\dfrac{W\,l}{4} = \dfrac{f\,L\,t^2}{6}$

centrated at its center, would be likely to fail, as shown in Fig. 1. It would first fracture along the diagonal lines from A to B, and then fail at or near the fixed edges along lines $B\,B$. The plate, of course, might also shear off along the edges $B\,B$, depending upon the method of loading the span L between supports, and the thickness of the plate. If the plate were merely supported along all the four edges, it would be likely to fail by breaking along the diagonal lines $A\,B$ only.

In the accompanying Supplement are given two tables of formulas for square flat plates. In Table I the plates are

plates firmly secured at all four edges and loaded with a uniformly distributed load. The fact that various authorities differ considerably, indicates the approximate nature of investigations along these lines. It is, however, important that formulas be deduced and used for designs of this character, because, while the formulas are only approximately correct, they indicate, in a general way, the dimensions required in flat plates, and the factor of safety assumed will always be taken large enough so that, practically, the difference between the various formulas is of small moment. It would be advisable, however, to use the formulas which give the greatest dimensions, indicating that they are on the safe side. Accompanying the present article will be found a table

for rectangular flat plates supported or secured at all the four edges and loaded in the center; in the tables where only one set of formulas is given, it indicates that the authorities quoted in the other tables do not give formulas for the case in question. As the formulas here collected usually are found only by diligent search in a number of different hand-books, and as these hand-books may not always be easily procurable, the author hopes that the collection will prove useful to many readers of MACHINERY who, at some time or other, may be called upon to lay out a design involving square or rectangular flat plates.

* * *

OIL TESTING MACHINE

An interesting machine for testing the durability of the lubricating qualities of oils has been designed by Mr. Paul Wendt, Kottbus, Germany. The machine, as shown in the accompanying engraving Fig. 1, reproduced from the *Zeitschrift des Vereines deutscher Ingenieure*, is mounted on a frame, and a slide A is moved forth and back by means of a crank motion. On top of the slide A is placed another slide B which rests freely on the lower slide, and is carried forth and back with it by friction only. When the contact surfaces of A and B are well lubricated, the inertia of the part B and the resistance offered by the mechanism will tend to make it move but little, but when the friction between the two surfaces becomes greater, the part B will have a tendency to follow the part A forth and back for the whole stroke. On the end of the rod passed through and secured to B, a ratchet pawl is mounted, which engages with the ratchet wheel C, provided with teeth of very fine pitch. When the motion of B becomes sufficient to turn the ratchet C one tooth space, the ratchet will stay in the position to which it had been moved by the engagement of the pawl D. On the same spindle on which the ratchet wheel is mounted is also mounted
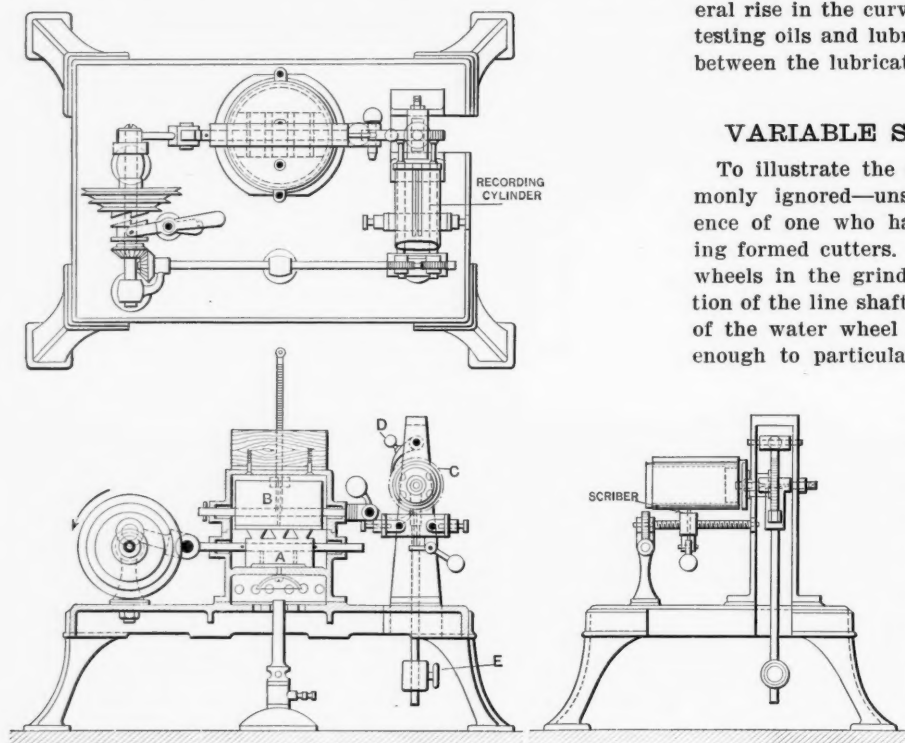

Fig. 1. Wendt Oil Testing Machine

dle on which the ratchet wheel is mounted is also mounted a cylinder around which is wound a sheet of paper, and under this cylinder is placed a scriber which is given a motion sideways, by a screw driven by bevel and spur gearing from the same crank-shaft which gives the motion to the slide A. On the end of the shaft, passing through the ratchet gear and recording cylinder, a lever is placed, on the end of which an adjustable weight E is attached. The lever hangs in a perpendicular position at the beginning of the test, but as the ratchet C is moved around, the lever and the weight will follow, moving to the right. By this means resistance to motion of the slide B and ratchet C is increased automatically, so that as the experiment proceeds, and the oil

deteriorates, the frictional resistance between A and B becomes greater, and a greater force is required to move the ratchet C one tooth space.

The apparatus is of value for comparing the qualities of different oils. In the two examples shown in Fig. 2, the diagrams indicate that in one case the oil retained its lubricating qualities practically unimpaired for fifty-four minutes, but then, having become heated, it very quickly became impaired in quality. In the other case shown, another oil re-
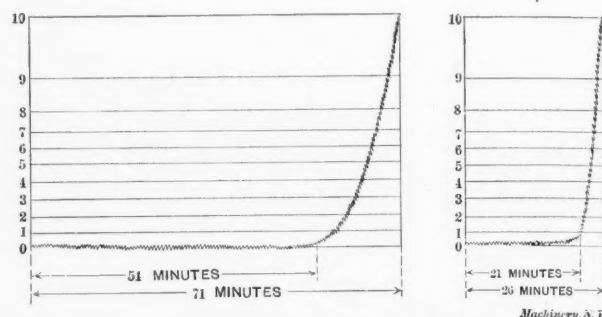

Fig. 2. Records produced on the Oil Testing Machine, showing Comparison between two different kinds of Oil

tained its lubricating quality only twenty-one minutes. By testing the oils by this machine, therefore, it was found that it would be likely that of the latter oil, more than twice the quantity would be required for equally good lubrication that would be required of the first kind of oil. The uneven character of the line recorded on the cylinder depends upon the fact that the slide constantly moves slightly forth and back and thereby gives a vibrating motion to the recording cylinder. But until the motions forth and back become large enough to move the ratchet one tooth space, there is no general rise in the curve produced. The machine is intended for testing oils and lubricants which are used in small quantities between the lubricated surfaces.

* * *

VARIABLE SPEED FACTOR IN GRINDING

To illustrate the effect of a factor in grinding quite commonly ignored—unsteadiness of speed—we cite the experience of one who has developed special apparatus for grinding formed cutters. When this work was first developed, the wheels in the grinding department were connected to a section of the line shafting driven by a water wheel. The motion of the water wheel was subject to some fluctuation, but not enough to particularly affect the grinding so far as casual inspection would show. There was trouble, however, from constant breakage of emery wheels, these having to be of very thin section to do the work required. A few years later, a steam turbine was substituted for the water wheel and at once a great reduction in the breakage of the wheels was noted. The steam turbine operated with more steadiness than the water wheel and to this fact alone is attributed the reduction in the breakage of the grinding wheels. It is not clear why the fluctuation of the water wheel should affect the grinding wheels in this manner. The amount of material removed in the grinding operation is small and the side-pressure on the wheels is low. The difference in operation due to the fluctuations of the water wheel should not account for the breakage, but the fact remains that the breakage has been greatly reduced with steadier motion. Who can give the best explanation?

* * *

According to *Page's Weekly* the results of the trials with the White Star liner *Laurentic*, which is equipped with a combined system of reciprocating and turbine engines, have been so satisfactory that it is probable that the same system will be used in the two giant steamers, *Olympic* and *Titanic*, which are now being constructed by Harland & Wolff in Belfast.

MAKING AN ENGRAVING BLOCK

ETHAN VIALL*

The old-time ball-vise or "sow-block," as it is known among die-sinkers, is scarcely recognizable in the beautifully finished engraving block of today, with all of its numerous adjustments and attachments; yet the rough old device with its rough-cast hemispherical-base and wooden pillow, was without a doubt the granddaddy of the present form. The engraving-block described in this article, was, as its name indicates, intended primarily for engravers' use only, but its useful-

finished. The block here shown certainly fills these requirements in every way. This block was originally designed by L. W. Géry, an engraver of New Orleans, and it is manufactured by Adolph Muehlmatt of Cincinnati, Ohio. Mr. Muehlmatt is a practical engraver and toolmaker of more than local reputation, who has from time to time added improvements as the demands of the trade or his own originality suggested them, and it is through his courtesy that we are enabled to publish the following article.

Mr. Muehlmatt manufactures two styles of engraving blocks: The regular and the keyless form, both of which with their
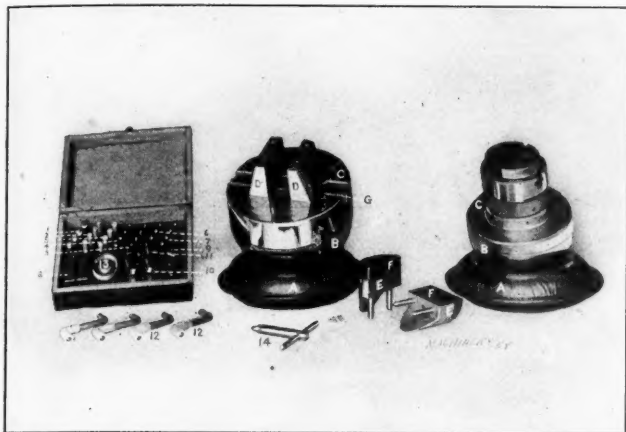
Fig. 1. Regular and Keyless Engraving Blocks and Attachments

Fig. 2. Partly finished Castings for the Spherical Base
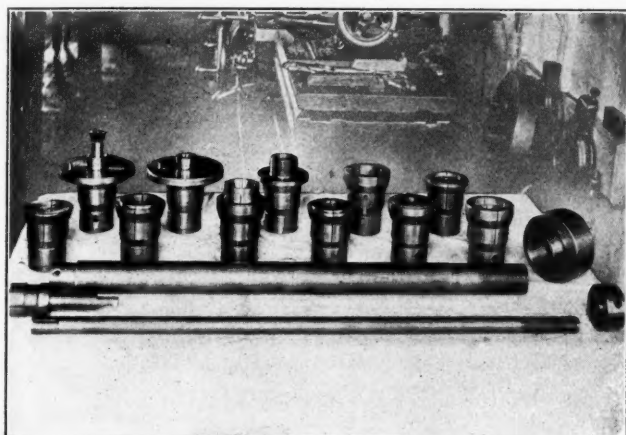
Fig. 3. Set of Split Chucks for Jones & Lamson Lathe

Fig. 4. Centering the Spherical Base
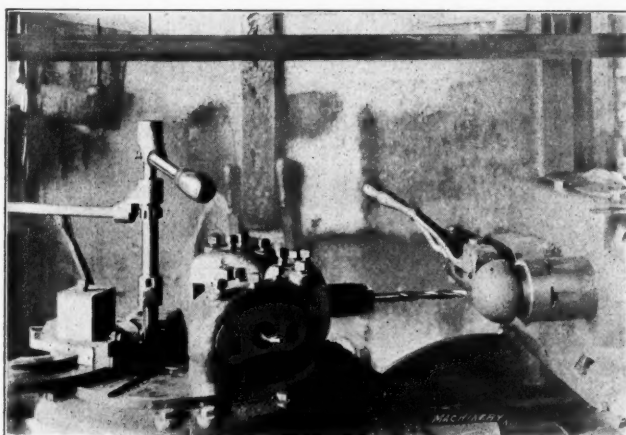
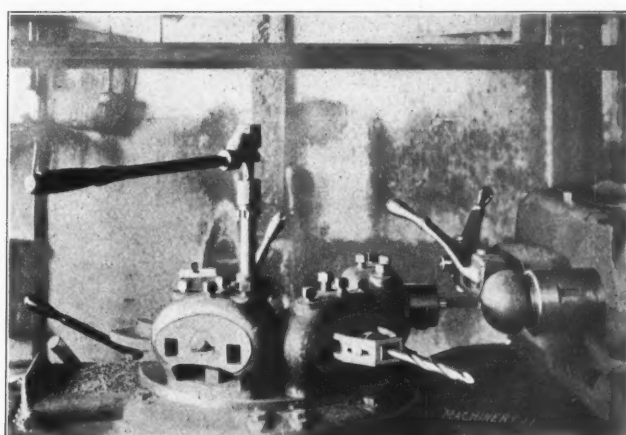
Fig. 5. Drilling the Hole in the Base

Fig. 6. Tapping the Hole in the Base

ness to the tool- and die-maker will be at once recognized by those not already familiar with it, for while it will hold delicate articles without crushing them, it will also hold anything within the capacity of its jaws, as firmly as any vise made, and in any workable position. There is nothing weak or fragile about the tool even if it is a beautiful piece of workmanship.

There are two things that must be kept in mind by anyone making goods for jewelers' or engravers' use; first, such articles must be well made, and, second, they must be well

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attachments are shown in Fig. 1. The jaws of the keyless block, which is shown at the right, are operated by a knurled ring in a manner similar to an ordinary scroll chuck. The regular block is, when shorn of its special attachments, simply a two-jawed universal chuck mounted on a turntable and "ball," the whole thing being set into a ring. This article will deal principally with the regular style, which is shown in detail in Fig. 7.

By examining Figs. 1 and 7 it will be seen that besides the two chuck-jaws *D*, there are two removable false jaws *E*, upon the top of which are placed two semi-circular pieces of

steel *F*, one of which is stationary and the other swiveled. These top pieces have holes drilled about three-quarters of the way through them for the insertion of the various attachments shown in the box and on the table at the left in Fig. 1. The numbers given to the parts correspond to those of similar parts which are shown in the line engraving, Fig. 8, except that 13 and 14 are omitted in the latter, as they are simply a key with a knurled head for light work, and a key with a
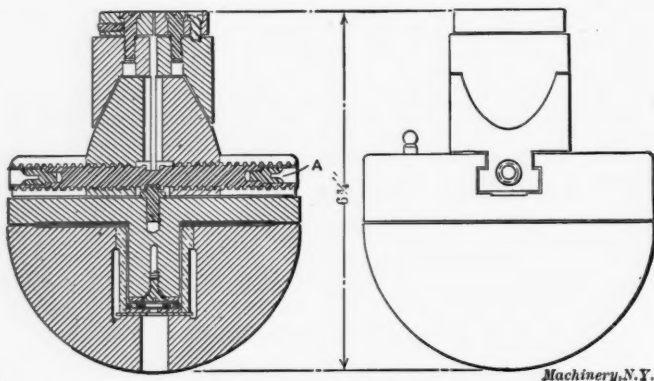

Fig. 7. Elevation and Section of the Engraving Block

cross handle for heavier duty. The way these attachments for the top pieces or third set of jaws, are used by the engraver for holding different shapes, is partially shown in Fig. 9. The method of holding a fancy pencil-case is shown at *A*; *B* shows the bowl of a spoon clamped to the block; *C* a spoon handle, and *D* a small locket or pendant. The large rubber-covered hooks shown at 12, Fig. 1, are intended to hold large metal plates, and they are usually used directly in the jaws *D*. The length of the two pins in the false-jaws *E* is such that the jaws will stand, as shown in the engraving. This is often a desirable feature when special attachments are used and the work is interrupted and must be removed for a few minutes on
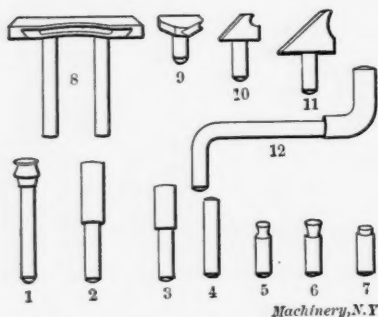
Fig. 8. Auxiliary Attachments for the Block

account of other and perhaps heavier work. The pillows *A* shown in the halftone are leather rings which are filled with sand. These rings are far more "clinging" and satisfactory than wood or metal ones.

Making the Bases

The hemispherical, or "ball" bases *B*, are made of cast iron and are cored out to make them light and convenient to
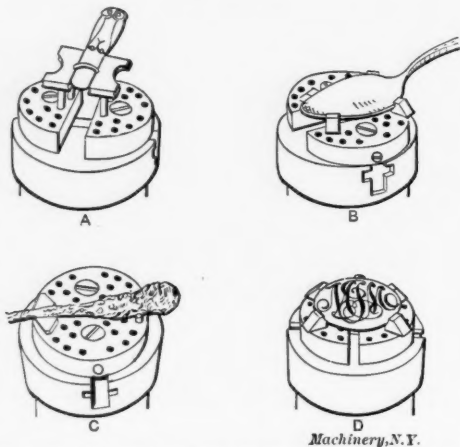

Fig. 9. The Way in which Irregularly Shaped Pieces are held by the Auxiliary Attachments

handle. In machining these bases they are first placed in an ordinary three-jawed chuck; the "flat" part is then turned and the hole bored as shown by the barrel of castings in Fig. 2. The bases are next held in a Jones & Lamson flat turret lathe, by means of the bored holes which fit over an expanding chuck.

Most men who have worked in the big watch factories have a strong liking for split chucks, and Mr. Muehlmatt is no exception, as will be evident by examining Fig. 3. This
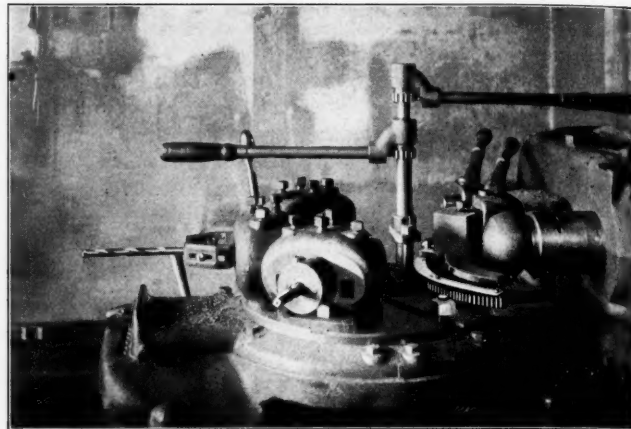

Fig. 10. Attachment for Turning the Spherical Surface of the Base
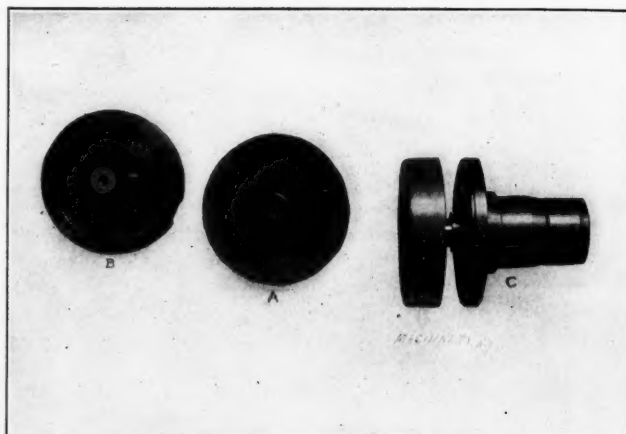

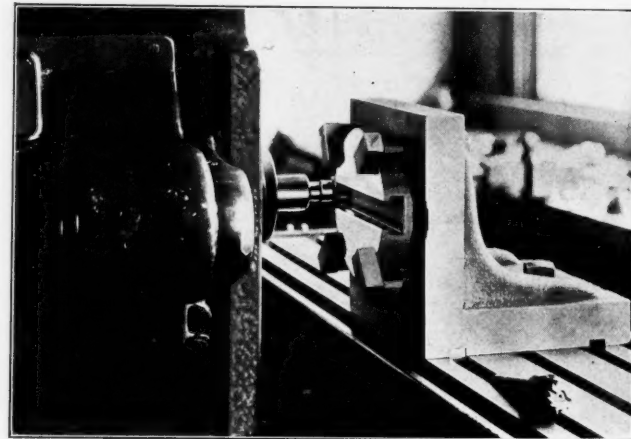Fig. 11. Turntable of the Block with Jig and Chuck for Machining it
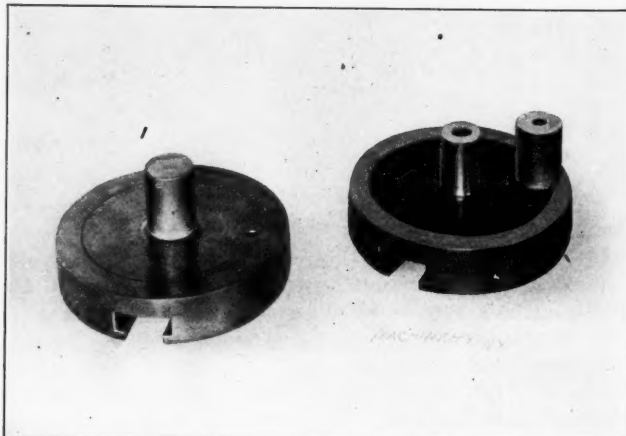

Fig. 12. Finishing the T-slot in the Turntable

Fig. 13. Method of Protecting Turntable Bearings from Plating Solutions

complete set of spring chucks, both expanding and contracting, types, together with the quill and rod shown, were made for use on the Jones & Lamson lathe, to do this special work. It

is seldom that work of this kind is done on a lathe of this type, so that it is worthy of more than passing notice.

Centering, Drilling and Tapping

After placing the base on the expanding chuck, the first operation is to center it for starting the drill, as shown in Fig. 4, using the usual form of flat centering tool. The hole is then drilled, and tapped as shown in Figs. 5 and 6.

right shaft having two ratchet hand-levers on the upper end. These ratchets are very convenient, as they not only allow the levers to be in any position while they are being used, but also allow them to be swung out of the way during the other operations.

After the bases are removed from the lathe they have a small hole drilled in the flat or top part for a stop-pin that locks the turntable and base together when the swiveling
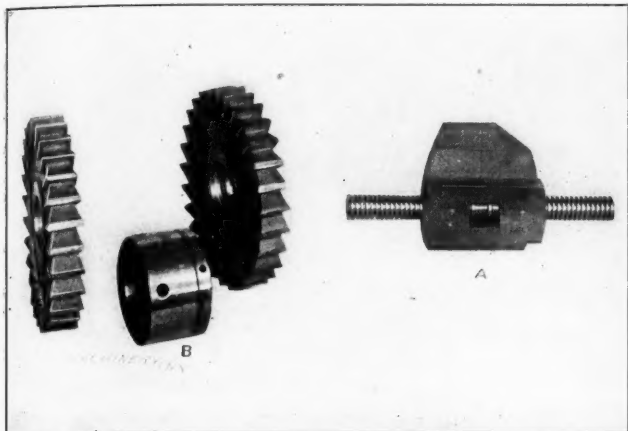

Fig. 14. Micrometer Spacing Collar—Jaws ready to be Machined
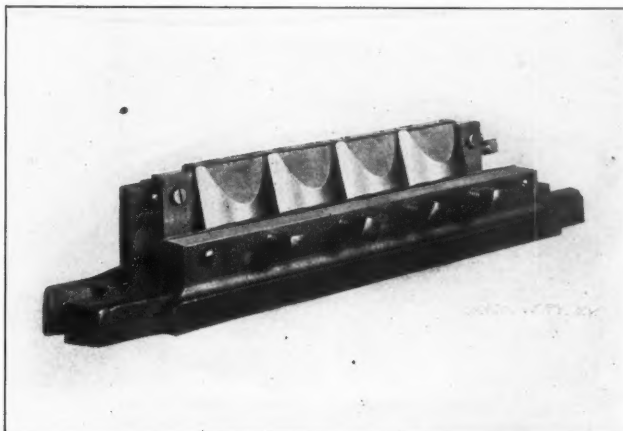

Fig. 15. Fixture for Holding Jaws while Milling the Bevel
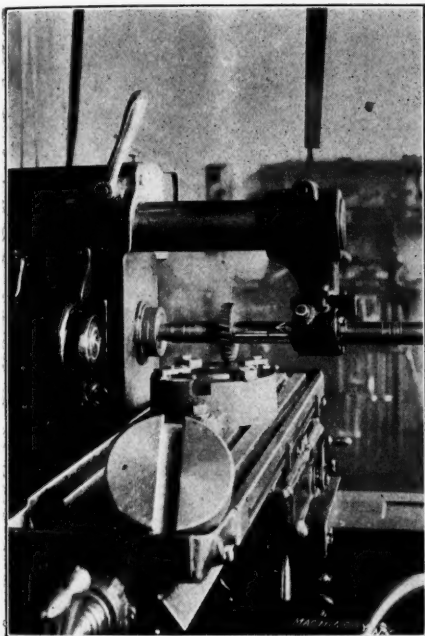

Fig. 16. Channelling out the Turntable for the T-slot

Fig. 17. Damaskeening the Turntable Top in a Drill Press
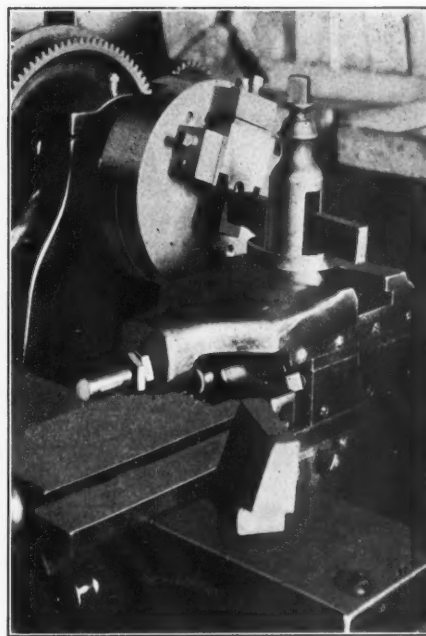

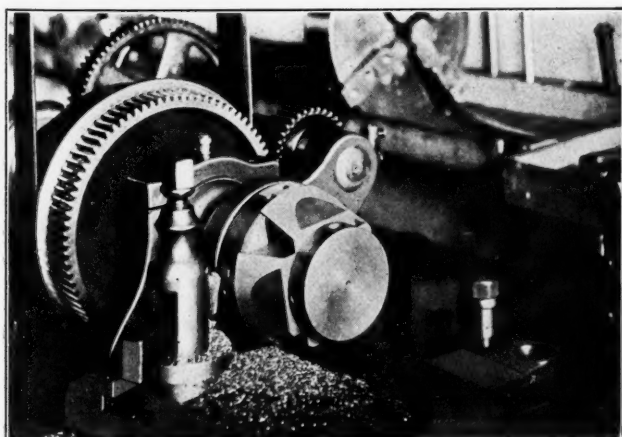Fig. 18. Boring, Threading and Facing Jaws in a Lathe

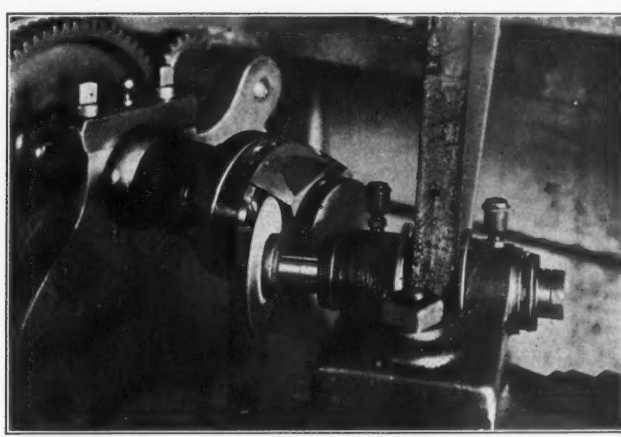Fig. 19. Turning the Outside of the Jaws in the Lathe

Fig. 20. Grinding the Outside of the Jaws

Turning the Hemisphere

The next operation consists of turning the spherical surface, using the device shown in Fig. 10, which was designed by Mr. Muehlmatt. As will be seen, the device consists mainly of a circular-shaped rack or gear-segment carrying a tool-post and tool, which is turned by means of a small pinion, mesh-ing with the gear teeth. This pinion is fastened to an up-

motion is not desired. They are then ground and polished ready for the nickelplater.

Machining the Turntables

The turntables C, Fig. 1, a rough casting of which is shown at A, Fig. 11, are first held in a regular chuck, the bottom and stem turned and the small hole for the screw that holds the hardened washer drilled and tapped. The stop-pin hole

is next drilled, using the jig shown at *B*, which slips over the turned stem. This jig is also used to drill the hole in the base just referred to, a collar on one side just fitting the large hole in the base. In this way the stop-pin holes in the two parts are sure to line up. Two small bushed holes are in the jig shown because it is used for two different sizes of engrav-
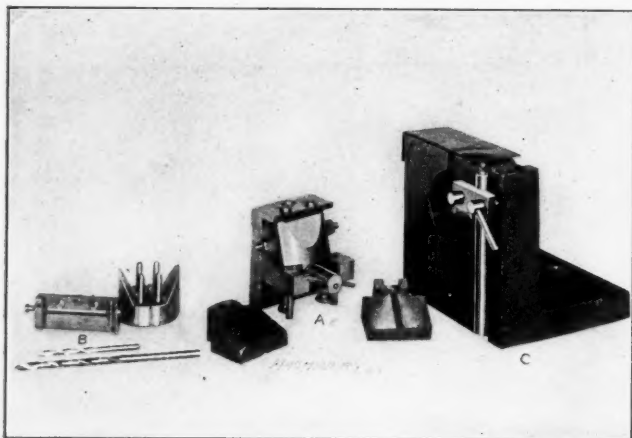

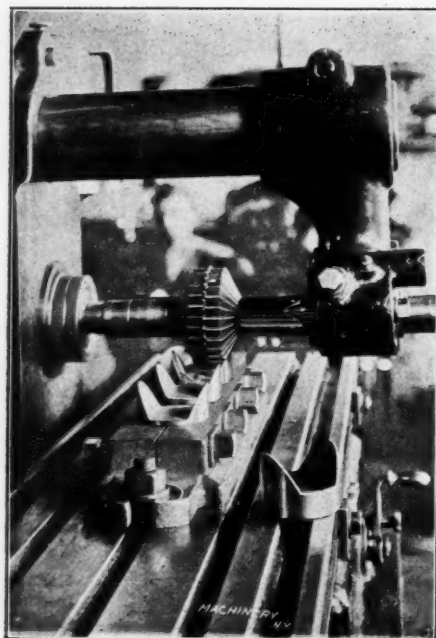Fig. 21. Two Jigs and a Fixture used in the Construction of the Block

ing blocks. The partly machined turntable is next held in the split chuck *C*, which fits the Jones and Lamson lathe, and the face and outside diameter is turned. The chuck *C* has a face-plate attached to it which has a pin in it fitting the stop-pin hole of the turntable; this pin acts as a driver.

Milling the T-slot for the Chuck Jaws

When the turntables go to the milling machine to have the T-slots for the chuck jaws cut in them, they are placed in the fixture shown in Fig. 16

Fig. 23. Milling the False Jaw Blanks

Damaskeening the Turntables

The fancy spotting or damaskeening of the turntable tops is done on a small drill press (Fig. 17), the turntable being revolved on its own stem, which is set into a socket in the special base. The spotting tool used is simply a piece of steel rod, to the end of which is cemented a disk of leather. In
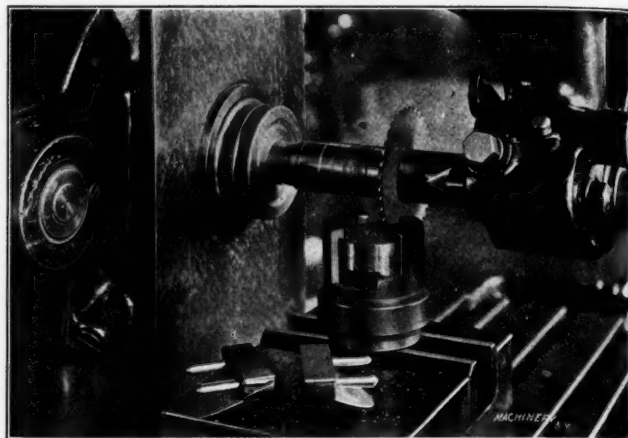

Fig. 22. Splitting the False Jaws in the Milling Machine

doing the work the top of the turntable is smeared with fine emery and oil and it is turned with the left hand while the right works the rapidly revolving tool up and down by means of the hand lever.

Machining the Jaws

Most of the ordinary straight milling on the chuck-jaws, such as facing off the top and sides, is done by holding the piece in the regular vise, but for truing the face of the jaw and boring and threading the clamping screw hole, they are held in the lathe by the fixture
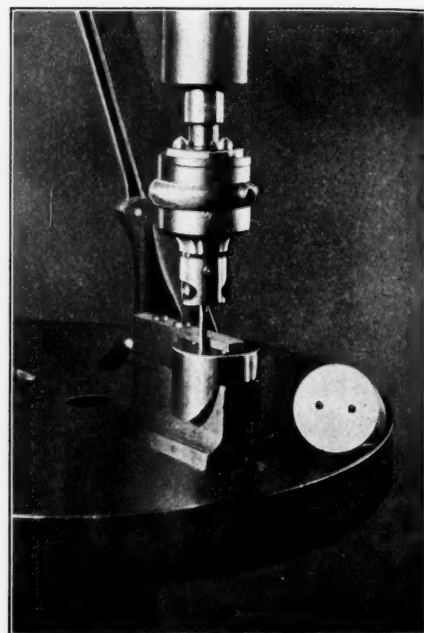

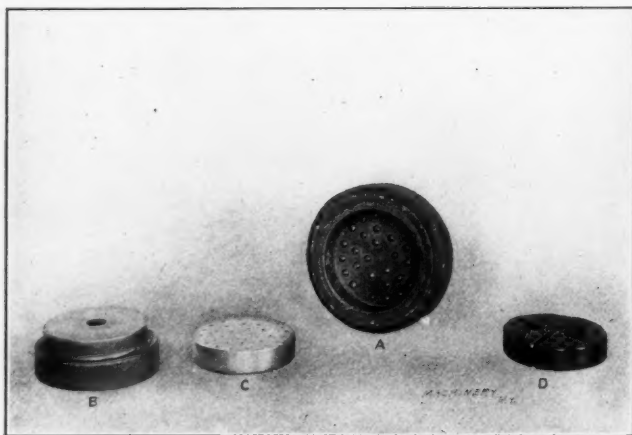
Fig. 24. Jig and Tapping Head for the False Jaws

Fig. 25. Tools for Laying Out Holes in Jaws F, Fig. 1

and channelled out. They are then transferred to the angle-plate jig, Fig. 12, and the T-slot finished. The edges of the slot are next rounded with the milling cutter lying on the table; the parts are then ready for the final grinding and plating.

In plating, it is undesirable to have nickel or copper deposited on the stem as it is a bearing, so small metal caps, Fig. 13, are placed over the stems to keep off the solutions.
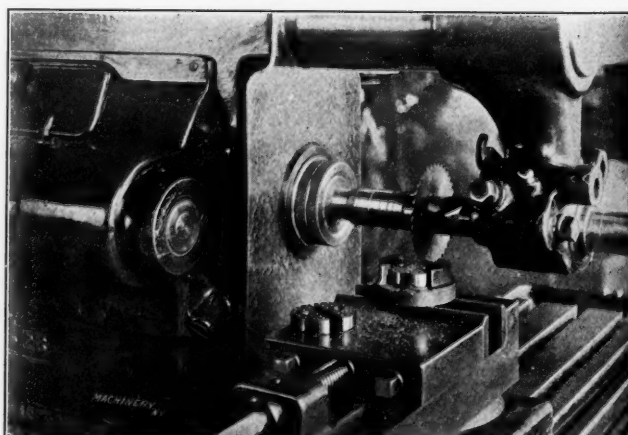
Fig. 26. Splitting the Jaws F, Fig. 1

shown in Fig. 18. After a pair of jaws have been screwed together, as at *A*, Fig. 14, they are "squared" all over and stamped as mates. In the final fitting to the turntable the idea is kept in mind that while the fit must be good, the parts must work freely and easily with no bind anywhere.

A micrometer-adjustment spacing-collar is shown at *B* in Fig. 14, which is very convenient for straddle-mill work.

In Fig. 15 is shown the fixture used for holding the jaws while milling the bevel on them, which is done with a bevel side-mill. Fig. 19 shows the way four of the jaws are held in the lathe while turning them, and Fig. 20 shows how the same fixture is used to hold them while they are being ground.
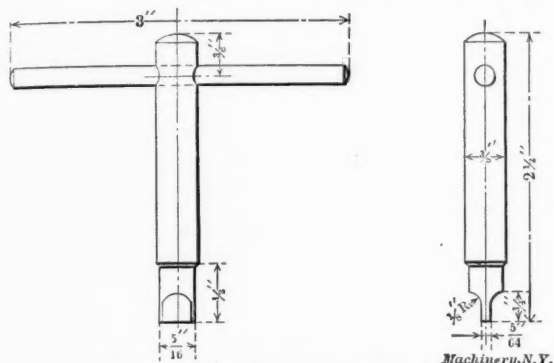

Fig. 27. Key used for Tightening the Jaws

When drilling the holes for the pins which hold the false-jaws in place, the chuck-jaws are placed in the jig shown at A, Fig. 21.

The False Jaws

The false jaws are both cast in one piece with a pin or stem on them similar to the one on the turntable, which is the holes for the upper jaw screws, the jig having a tongue which exactly fits this slot.

The jig and geometric tapping head shown in Fig. 24 are used while tapping the screw holes in the false-jaws; the jaws are then placed in a fixture and split in the milling machine, as shown in Fig. 22.

The upper or swivel jaws, F, Fig. 1, are at first only flat pieces of steel, which are placed, one at a time, into the box-like piece A, Fig. 25. The part B is then placed on top and a blow given it under the hammer, with the result that all the holes to be drilled in the piece are "spotted" at one stroke by the blunt punches in the bottom; the piece then appears as shown at C, while at d its appearance is shown after all the holes have been drilled and the piece split. This splitting is done as shown in Fig. 26.

By referring back to Fig. 7 it will be seen that the screw that clamps the jaws together has a rather peculiar arrangement in the ends for the key. Instead of having a square hole, drifted out as usual, it has a piece, A, pressed into it.

The way the screw-blank is held while the ends are drilled for this piece is shown at C, Fig. 21. After the holes are drilled the small pieces are forced in with a hand-press as shown in Fig. 28, the holder and shape of the punch used being shown in Fig. 29. The style and shape of the end of the key used is shown in Fig. 27. The way these small key-pieces are held while being slotted is shown in Fig. 30. Three other
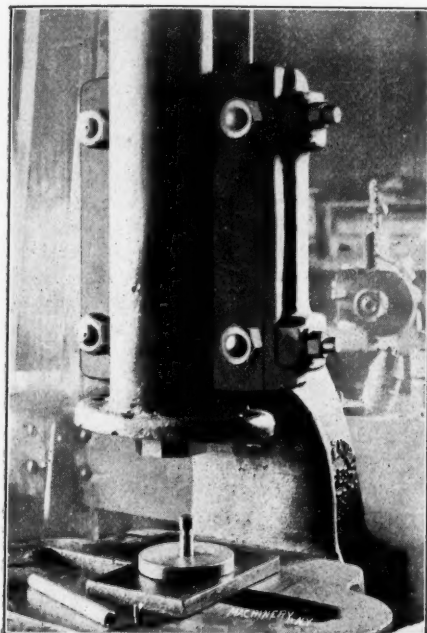
Fig. 28. Forcing the Piece A, Fig. 7, into Place
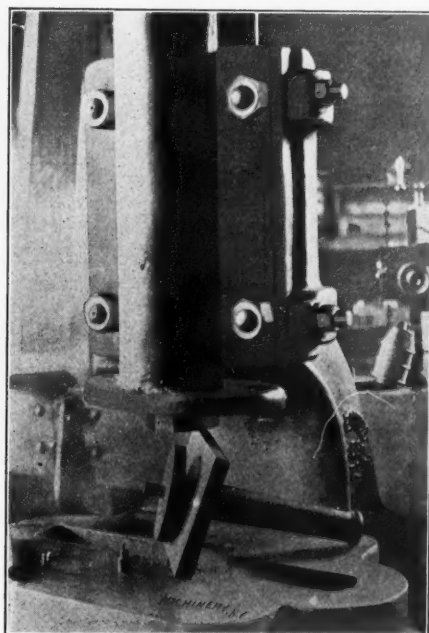
Fig. 29 View showing Holder and Shape of Punch
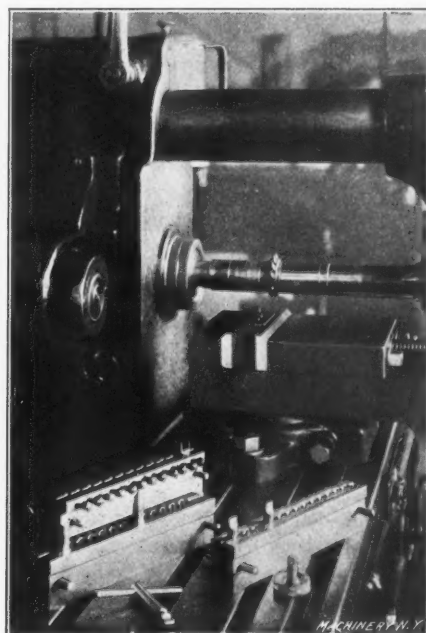
Fig. 30. Milling the Slots in the Pieces A, Fig. 7
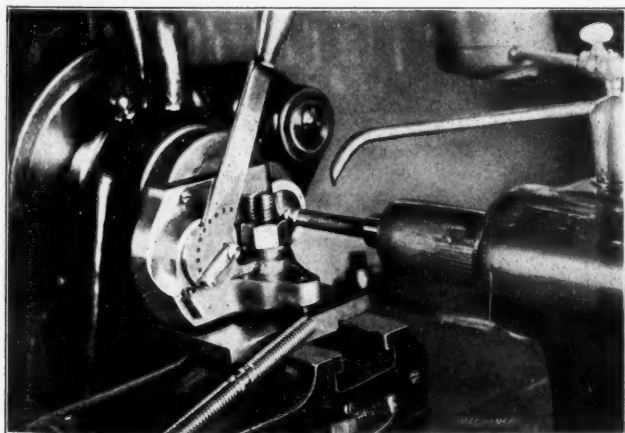
Fig. 31. Threading the Clamping Screws
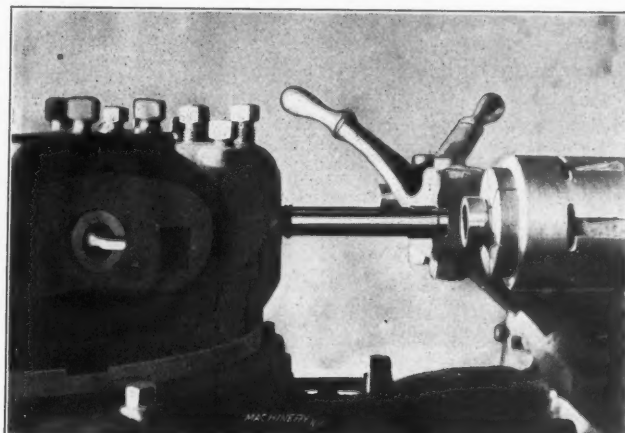
Fig. 32. Boring the Turntable Bushings

used to facilitate handling. The false-jaws are chucked by this stem, the outside turned and the stem is then cut off and the piece faced off at the same time. The blanks are next placed in the fixture, Fig. 23, and milled as shown. The slot which is sawed down the middle is put there to act as a guide for the drilling jig B, Fig. 21, used to drill the pin holes and

gang jigs are also shown on the table in this halftone. The forcing in of the slotted key-pieces necessarily swells the ends of the screw-blanks to some extent, but as the thread is cut afterward no harm is done. This thread is cut with a Rivett-Dock threading tool. One-half the screw is held in a split chuck with the outer end steadied by the tail-stock center, as

shown in Fig. 31, the blank having, of course, been previously turned to size.

Bronze bushings are set into the base of the engraving-blocks, as a bearing for the stem of the turntable. In machining the inside of these bushings they are held in a draw-in chuck in the Jones and Lamson turret lathe, rough bored, and then finished to size with a Schellenbach-Hunt adjustable boring-bar, as shown in Fig. 32. The use of a boring-bar

Fig. 33. Detail of the Ball Bearing for the Turntable

seems to be the best way to secure accurately bored bushings in this case, as any attempt to finish bore with a tool depending on a carriage stop will not give uniform results.

At the bottom of this bronze bushing as it rests in place in the base, is a special form of ball bearing which is shown in detail in Fig. 33. The cage consists of two punched disks held together by a hub onto which they are pressed and riveted fast. The manner in which this cage works between two hardened steel disks may be seen by referring to Fig. 7.
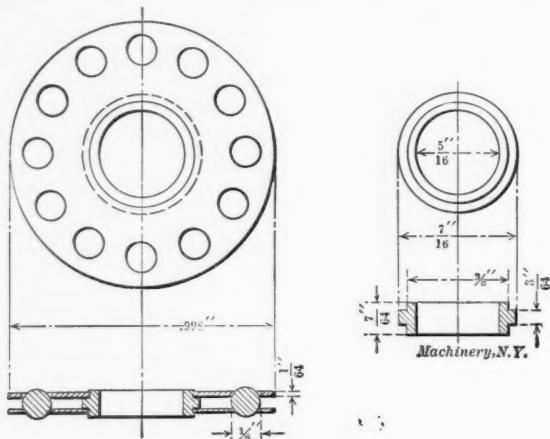
* * *

Reinforced concrete is rapidly coming into use as a building material and for making engineering structures of all kinds. It is a material admirably adapted for permanent structures, being practicably indestructible and gaining strength with age. It is not a material easy to handle, however, and special apparatus and experience are required to make a concrete structure secure. Some who are of the idealistic type, are dreaming of an ideal building material which can be molded into form without the difficulties and drawbacks of concrete, and one of the great developments of the future may be a partial realization of these dreams. It is possible that water will be the principal part of the new building material. Suppose that the normal temperature were at or below zero. Water would then make an ideal building material, provided, of course, that it could be readily obtained and that the interior temperature of the building would never rise above the melting point. Ice blocks would then be as good as concrete blocks, and finely divided ice could be used for the bond or mortar at the joints; or water-tight forms could be used to give the desired shape, the water being poured in, and allowed to freeze. Ice structures have been built in northern countries, and used for a variety of purposes, including exposition buildings of large size. The dreamers of an ideal building material have thought of the possibility of discovering a material which added in small proportions to water would cause it to crystallize and take permanent form having strength and heat-resisting qualities equal to cement. When we consider how little solid matter is required to make a firm jelly, it does not seem inherently impossible that the dream may be realized. Granting realization, then, monolithic construction would be reduced to the simplest terms, and the cost of transportation of the greater bulk of the material in cities would be eliminated, save that the charge for water is partly due to the cost of piping to the spot.

* * *

A great many women students are, at the present time, studying at the German engineering schools. According to a consular report, 1,230 female students are enrolled at the nine leading German engineering schools.

## PATENT LAWS AND THE COST OF MANUFACTURE

In the new British patent act a clause is inserted requiring that articles patented in Great Britain shall be manufactured in that country to "an adequate extent." The United States Consul J. M. McCunn of Glasgow, states that he has been informed that under this law parts of patented machines and devices could be manufactured in the United States and then simply assembled in Great Britain. The ground on which this view is taken is that each part of a machine considered separately is not a patented article, and that the patent merely applies to the machine as a whole. As no test case has been brought into the courts, the Consul states that the previous opinion is the generally accepted reading of the law until a test case has been brought. Should this be a sound opinion it would mean that the new British patent act would be valueless in bringing about the results for which it was framed, and the construction of the law along the lines indicated would be entirely out of harmony with ordinary common sense. From an engineer's point of view assembling in itself cannot be considered manufacturing. A manufacturer of patented articles would at least be expected to make the majority of the integral parts. It is admitted, of course, that it is difficult to draw a distinct line between actual manufacturing and assembling. Many automobile firms, for instance, buy a large proportion of the parts ready-made from manufacturers of specialties in that line, yet, these manufacturers are generally and properly considered makers of automobiles. When assembling pure and simple is referred to, however, it is clear that no engineer would refer to the process as manufacturing, and the British lawyers who would interpret the new law to that effect are likely to find it rather difficult to convince an intelligent court, and even more difficult to secure expert testimony to support their view of this matter.

Taking larger views of the question, however, and considering from the productive engineer's point of view the benefit derived fom a law requiring patented articles to be manufactured in every country where the patent is granted for the article, there is considerable chance for difference of opinion with the framers of the new British patent act. While it is reasonable to require that every inventor or firm owning an invention should make use of it if a monopoly in the manufacture of the article in question is expected, it is not so clear that it is reasonable to require that every patented article should be manufactured in every country where the patent is in force. Such a requirement is simply an indication of the narrow sphere of thought from which mankind is slowly emerging, and is distinctly uneconomical from the productive engineer's point of view. It requires a duplication of plant and special machinery at great expense; in the end no actual benefit is derived by anybody, and the productive capacity of a great number of people is merely turned into wrong and useless channels. The engineer is concerned primarily with the reduction of the cost of production, and to him the question of prime importance should be to what extent any special law reduces this cost. From the engineer's point of view it would evidently be best that the whole world's supply of a certain article be manufactured in one or a few places where the cost of production of that certain article is the lowest. Of course, the economic gain from centralized manufacture would be lost in cases of exceptionally bulky or heavy manufactures, where increased freight charges would become a serious item. In this connection tariff duties between different countries ought to be considered, but as these are artificial and not natural barriers, the engineer may disregard them for the moment when he endeavors to arrive at a law governing the most economical methods of production. In the final analysis, of course, the results of tariffs between different countries must also be considered, as they increase the cost of production of the world's total supply of any one article, and consequently work in opposition to the constant aim of the engineer of decreasing the cost of production and devising means for producing the largest amount of goods at the smallest expenditure of labor.

MACHINE SHOP PRACTICE*

TWIST DRILL GRINDING

The drill is one of the most common tools used by the machinist and it is also the tool which, perhaps, receives the most all-round maltreatment, as will be evident by examining the supply in the average shop. Broken drills and poorly ground points are very closely related, as one is often the effect of the other. An improperly ground drill also means that the quantity and quality of the work is affected; hence, the mechanic should know what the requirements for a correctly formed drill point are, for while it is impracticable to grind a drill theoretically correct by hand, such knowledge will enable one to more closely approach the true form. A machine especially designed for this purpose is, however, to be recommended. The requirements, briefly stated, are as follows: The two cutting edges should be equi-angular with
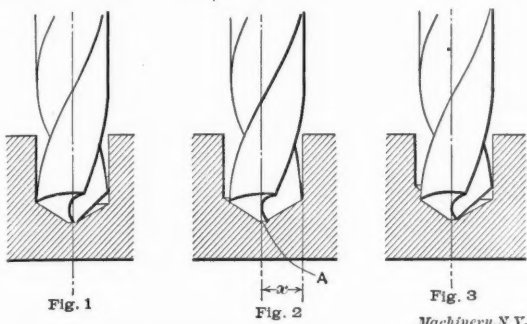
Figs. 1, 2 and 3, illustrating the Effects produced by Drill Points improperly ground

the axis, and of the same length; the angle of clearance for each cutting edge should be the same, and the clearance should increase toward the center of the drill.

In Fig. 1 is shown the relation of the drill point to the hole bored, when the cutting edges are not at the same angle with the axis. As will be seen, one side will do all, or at least a greater part of the work, thus subjecting the drill to an unbalanced torsional or twisting strain, which does not occur when each cutting edge is in action, as then the tendency of each side to spring away from the cut is counterbalanced by the opposite side. The drill will also be forced against the side of the hole, resulting in an enlargement of the latter.

The effect produced when the lengths of the cutting edges are unequal is illustrated in Fig. 2. As the drill, when it is fed into the metal, revolves about the center A, the horizontal distance x, from this point to the longest side, will be equal to the radius of the hole, which will, of course, be larger than
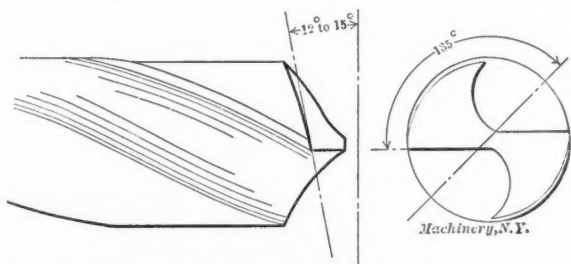

Fig. 4. Clearance Angle at the Periphery and Angle that the Point should make with the Cutting Edges

the drill diameter if the point A is not central; hence, if holes of the correct diameter are to be drilled, each cutting edge must be exactly the same length. In Fig. 3 is shown a drill point having cutting edges inclined at different angles to the axis, and of different lengths, thus combining the disadvantages mentioned in the foregoing.

The clearance for the cutting edge is a very important feature of drill grinding. Drills split through the web are usually an indication of improper clearance or excessive feed. If the end of the drill conformed exactly to the shape of the bottom of the hole, obviously it would not cut, as the lack of clearance would make it impossible to sink the cutting edges into the metal; consequently, when there is insufficient clearance for a given feed, the drill binds back of the cutting edges, thus sub-

* With Shop Operation Sheet Supplement.

jecting it to an excessive torsional strain. Theoretically, the clearance should be just enough to permit the drill to cut freely, in order to give the cutting edges the maximum amount of support. The Cleveland Twist Drill Co. advocates a clearance angle of 12 degrees at the periphery of the drill, with a gradual increase toward the center until the point or line joining the two cutting edges is at an angle of 135 degrees, as shown in Fig. 4. When soft material is to be drilled and heavier feeds are used, the angle of clearance may be increased to 15 degrees, while for hard material such as tool steel, for example, the amount of clearance can be diminished as the feed must necessarily be light, and a strong cutting edge is required.

As previously stated, the clearance should gradually increase toward the drill point. The reason for this will be

Fig. 5. The Angles of the Helical Paths described by the Points A and B show why the Angle of Clearance should increase toward the Drill Point

apparent by considering the movement of two points A and B (Fig. 5) on the cutting edge, as the drill is fed downward, one point being much nearer the center than the other. Assuming that the feed is constant, the path described by each of these points will correspond to that indicated by the helical lines shown. As the vertical distance x that each point moves per revolution of the drill will be the same, the angle of the smaller helix or spiral will be greater than that of the larger one. The angle of the helix, in each case, indicates the minimum clearance necessary at that particular point, for a feed per revolution equivalent to the distance x. The amount of feed indicated has been greatly exaggerated in order to make the comparison clearer.

There is a difference of opinion concerning the exact shape of a drill point, both in regard to the form of the end and
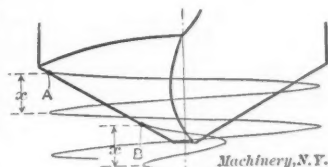

Fig. 6. Form given to the Lip of a Drill by the Sellers Drill-grinding Machine

the angle between the cutting edges. The Sellers grinder (the operation of which is described in the Shop Operation Sheet accompanying this issue) so controls the drill in relation with the grinding wheel that the surface of each lip conforms to the segment or part surface of a cone, as shown in Fig. 6. The axis a-a of the cone is inclined to the axis b-b of the drill, and also lies in a different plane, as shown in the view to the right, thus giving the cutting edge the required clearance which, obviously, increases toward the drill point. If we assume this hollow cone to be a grinding wheel revolving about the axis a-a with the drill point held against it as shown, the surface of one lip will evidently be ground to the desired conical form. It is not necessary, however, in order to grind each lip to this form, to resort to such a method. In the drill grinding machine referred to, this same surface is produced by turning the drill, which is held in a suitable chuck, around the axis a-a of the cone, while an emery wheel having a flat surface tangent to the surface of the cone, grinds the point.

As to the angle of the point, recent tests (the results of which are given in this and the May issue) have demonstrated that an included angle of 118 or 120 degrees is about right. The pressure required to force a drill through the metal be-

comes less as the angle of the point is diminished, but the power required to turn it increases; therefore it is not advisable to have the angle of the point too acute, as then the power consumption 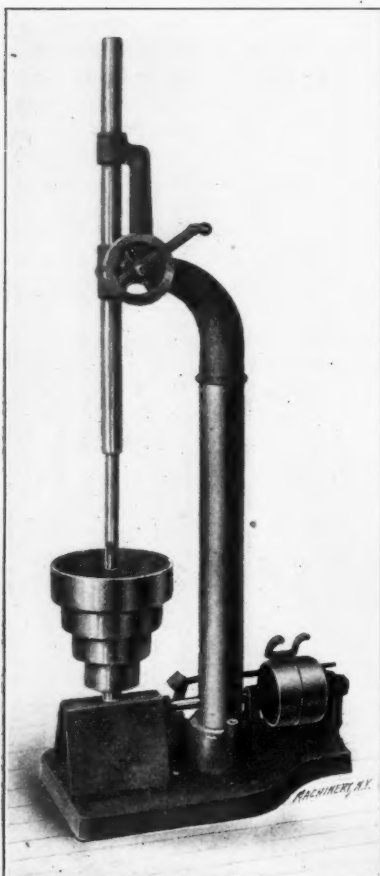will be too great, and, on the other hand, the point should not be too blunt, owing to the excessive end-thrust and the resulting strain on the machine.

* * *

REAMING MACHINE FOR CHAMBERED HOLES IN PULLEYS AND SPINDLE SLEEVES

The difficulty of obtaining a true hole when reaming in a lathe or drill press, particularly when the parts to be reamed have chambered or relieved holes, is well known; in the latter case it is almost impossible to get the two ends of the hole to line up, even though floating reamers be used for this purpose. In order to overcome these difficulties the Hoefer Mfg. Co., of Freeport, Ill., has built, for use in its own shop, the reaming machine shown in the accompanying illustration.

The base and column are the same as used for the company's regular 16-inch drills. The metal cover fastened to the base encloses a bracket carrying a bevel gear and pinion transmitting the power from the pulleys shown, to the spindle of the device. The key or drift hole of this spindle is shown just below the cone pulley. The end of the spindle which points upward, fits a No. 3 Morse taper and holds the shank of the reamer arbor. On this arbor an adjustable shell reamer is placed, and at the upper end of the arbor, just above the reamer, a small pilot is provided which enters into the guiding arbor above it. This guiding arbor is, in turn, held in the non-rotating spindle carried by the column. As shown in the illustration, a rack is attached to this spindle by means of which it can be raised and lowered by the wheel and lever shown.

Machine for Accurate Reaming of Long Holes in Pulleys, Sleeves, etc.

The device is used for reaming spindle sleeves, pulleys and the holes in various gears. These holes are first bored in a drill press by means of a special boring bar extending through the cored hole of the sleeve into a revolving bushing in the base of the jig. The boring bar is provided with two double-ended cutters placed about one inch apart, one cutter being used for roughing, and the other for finishing the hole about 0.010 inch under the standard size. The guide bar of the reaming machine (held in the upper non-rotating spindle) is ground to a sliding fit for the bored pulley or sleeve.

In operating the reaming machine, the upper non-rotating spindle with its guiding arbor is raised, and the pulley is slid onto the arbor. The spindle is then lowered until the guiding arbor engages the pilot on the end of the reamer bar, and the operator starts up the machine, meanwhile holding the cone pulley with both hands on opposite sides of the rim. As the lower spindle rotates, he exerts a slight pressure on the pulley, thereby feeding it over the reamer until the latter comes through at the top. Since the guiding bar above and the shank of the reamer arbor below quite closely fit the hole before and after reaming, respectively, any error in the alignment of the hole is hardly possible. The upper and lower

corners of the reamers are stoned off by a small oil stone, and a very smooth hole results in the work. The reaming is done by the drill press operator, who performs the reaming operation while a hole is being bored in the drill press, the two machines being placed near together. In the illustration a pulley is shown finish reamed, the reamer being visible at the upper end of the pulley, which is supported by the shank of the reamer arbor.

* * *

OFFSETTING CYLINDERS IN SINGLE-ACTING ENGINES*

A great deal has been said recently about the offsetting of cylinders in single-acting engines and many claims of superiority are made by those who employ this form of construction. About twenty-five manufacturing establishments in the United States are building engines in which the cylinders are offset, chiefly those of the automobile type, and one company is formed for the purpose of making engines in which the offset is equal to the crank radius and the connecting rod length is about 3⅞ times the crank radius. Among the claims made by manufacturers for offset engines are: greater power, less side-pressure of the piston on the walls of the cylinder, better turning effort, less vibration, smoother running qualities and when one cam shaft is used, a more convenient mechanical arrangement.

The author of this paper gives a complete mathematical analysis of the effect on the length of stroke, turning force, side-pressure of piston on cylinder, etc., under various conditions of ratio of length of crank to length of connecting-rod and amount of offset, the latter ranging from zero to an amount equal to the length of the crank. The mathematical expressions by which these conditions are investigated take into account the length of the crank, the length of the connecting-rod, the amount of offset, the area of the piston head, the weight of the reciprocating parts and the revolutions per minute. The engines of various manufacturers are made by means of these mathematical expressions, and the effects on side-pressure, vibrations, etc., are all tabulated. In brief, the results of these investigations may be summarized as follows:

Offsetting increases slightly the length of stroke and the crank angle passed over during the stroke toward the crank shaft.

The maximum value for the side-pressure of the piston on the cylinder walls decreases as the offset increases up to the value of one-half the crank radius for any ratio of $L \div R$.

The work lost in friction due to the side-pressure of the piston on the cylinder walls decreases as the offset increases up to a value of 75 per cent of the crank radius.

Both the maximum value of the side-pressure and the work lost in friction increase as the value of the ratio $L \div R$ decreases.

Offsetting decreases the height and weight of the engine.

Offsetting increases the life of the cylinder and piston.

Offsetting improves the thermal cycle.

The author makes the following comparison of the importance of these various considerations:

Improvements due to offsetting, (1) in the thermal cycle, (2) in the mechanical arrangement, (3) in the turning effort curve, and (4) in lubrication, are very slight and may be neglected. The real advantages are:

a. A reduction of the frictional losses due to the pressure of the piston on the walls of the cylinder, resulting in a slight increase in mechanical efficiency and less wear of the piston, piston rings, and cylinders, and consequently longer life.

b. A reduction of the maximum value of the side-pressure of the piston on the walls of the cylinder allowing the use of shorter connecting rods, shorter pistons, and shorter cylinders, resulting in a shorter and lighter engine and in lower inertia-forces due to the reciprocating parts.

The most important of these advantages would be a considerable saving in weight.

The disadvantage of offsetting lies in the fact that the reduction in average side-pressure and maximum side-pressure grows less as the speed and inertia-force increase, so that for a speed of 1,400 to 1,500 R. P. M. there is either no reduction at all or an increase.

BORING MILL GAGE AND A SWAGE HOLDER

A short time ago B. W. Cooper, general manager of the Danville Foundry & Machine Co., showed me a handy little attachment used on their big boring mills for sizing large pulleys and fly-wheels. The device (shown in Fig. 1) consists of a bar of one-inch cold-rolled steel about three feet long, fastened by cast-iron brackets to the inside of the housing of the mill and back far enough to clear the cross-rail nicely. On this bar is a sliding cast-iron bracket carrying a
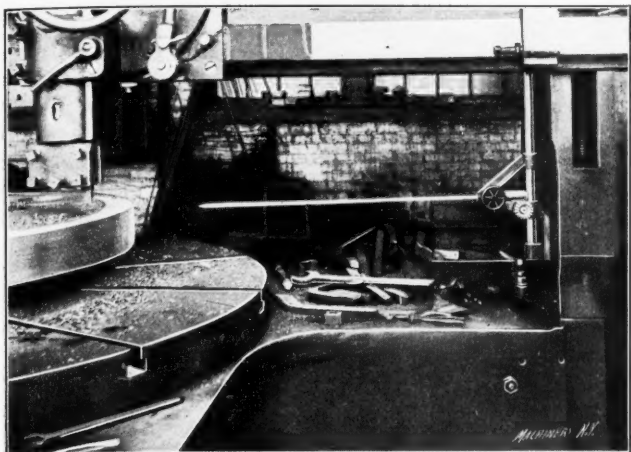

Fig. 1. Device for Measuring Circular Work on the Boring Mill

measuring rod, as shown in Fig. 1. Rods of suitable length for sizing every standard-size pulley or fly-wheel made in this shop are kept in a rack close to the mill, and when a job is put on, a rod numbered to correspond to the number of the casting to be turned is put into the socket in the bracket and shoved in as far as it will go. It is then locked in place by turning the little hand-wheel screw shown. With this device, work can be brought to size with the mill running at full speed, as the right diameter has been obtained when the point of the measuring rod will just swing past the piece.
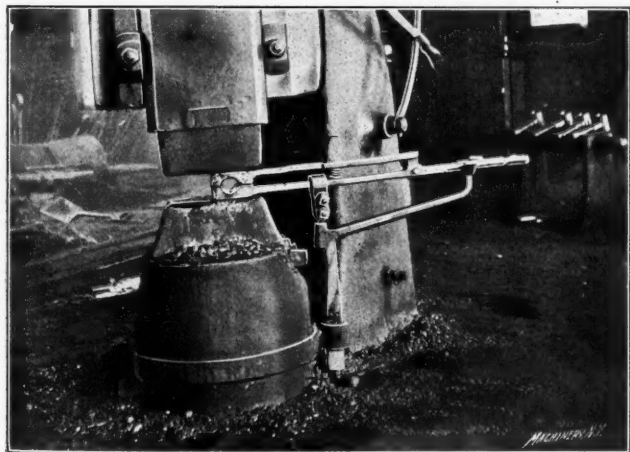

Fig. 2. A Steam-hammer Swage-holder or "Deadman"

When the gage is used with the machine revolving it should be swung against the work from the rear side or against the direction of rotation to prevent it from being forced past and bent. This tool may be used effectively on any large circular work, the outside of which is turned on a boring mill, as anyone who has had to use calipers on such work will understand.

Another very good thing that I saw in this shop is the "deadman," or swage-holder for the steam hammer, shown in Fig. 2. For the blacksmith, with only one helper who must be used to operate the hammer, this tool is extremely useful. As will be seen, the holder is made to take almost any style of spring-swage and is adjustable for height by means of staggered holes in the upright piece and a pin in the socket

on the base-strap. The base-strap can also be moved around the block by loosening the clamping bolt, which allows the swage to be placed in different position on the anvil.   E. V.

AN IMPROVED REAMER HOLDER

When reaming in the lathe the tendency for a reamer to slip off the center is not due to any inclination of the reamer itself to draw into the hole faster than it is fed in, but due rather to the fact that there is very little stock being removed, and that the reamer is usually held from rotating by a dog or holder of some kind which acts on one side only, thereby tending to pry the reamer off the center. When a reamer is held in this way there is also a liability of its reaming different size holes owing to the fact that sometimes it may have a little more stock to remove than at others, and that it may be fed faster in one hole than another; which in either case would tend to spring the reamer a little more out of line in one hole than another, thereby causing the holes to vary in size. This is especially true with small reamers with long shanks.

To overcome these difficulties the writer devised the holder shown in the accompanying illustration. The idea in part was borrowed from Prof. John E. Sweet's double-tailed dog. Referring to the sketch, A was made from a piece of machinery steel about $\frac{7}{8}$ inch x $1\frac{1}{2}$ inch x 5 inches. The clearance
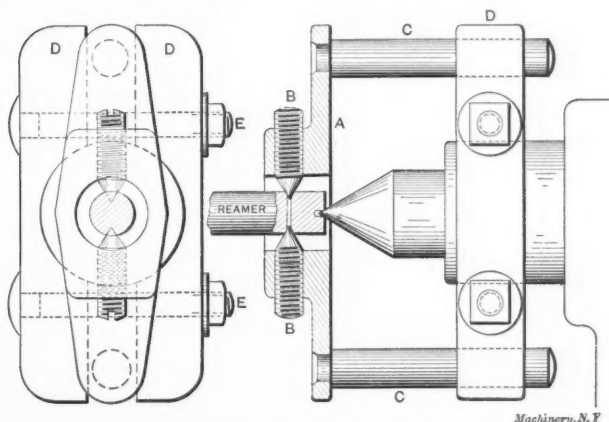
Holder which prevents a Reamer from Sliding off the Center

hole for the reamer shank is 1 inch and it will take reamers up to $1\frac{1}{8}$ inch in diameter and some larger ones, this depending, of course, on the size of the shank. The holes for the pivot screws B should be drilled and tapped clear through from one way before the clearance hole for the reamer is drilled, so as to bring them nicely in line. The pivot screws are made from tool steel and hardened; the included angle of the points is 60 degrees. The studs C are $\frac{1}{2}$ inch cold rolled steel. The driver D which is clamped on the tailstock spindle, is made from hard maple, which answers the purpose just as well as though it were made of cast iron or steel. A good way to make it is to bore a hole in a block of wood to fit the tailstock spindle, and drill the holes for the carriage bolts E; then cut enough out through the center of the block so that the studs C will be a loose fit in the slots when the driver is clamped in place as shown.

To get the female centers in the reamer shank approximately in line to receive the pivot screws, drill a small hole through the shank of the reamer and countersink with a center reamer. It is not necessary that the hole should pass exactly through the center of the shank. The shanks of most reamers will be found soft enough so that they may be drilled readily. The studs C fit loosely in the blocks D, but when the reamer tries to rotate they come against these blocks, and being on opposite sides of the reamer and self-adjusting, the reamer will be held without any cramp, and there will not be any tendency for it to lift off the center. In using this holder all that is necessary for safety is to pass a string or belt lace around the holder and driver and hold it with one

hand, well out of the way, while feeding with the other. Another point of advantage is that the shanks of the reamers will not become marred or bent.

Syracuse, N. Y.　　　　　　　　　　　GEORGE G. PORTER.

DISTINCTIVE COLORS FOR PIPING IN A MANUFACTURING PLANT

The question of using distinctive colors for the various lines of piping in a manufacturing plant is one that has scarcely received the consideration that it deserves. The fact that a pipe is a pipe and that the line gives no trouble is enough for a great many superintendents and works managers. If there be any trouble there are the plumbers and pipe fitters

PIPING ⬭		
Light and Power 220 V.	Black	
Light and Power 110 V.	Dark terra cotta	
Telephone Bells	Pea Green	
Patrol	Blue	
Live Steam and Drips	Canary yellow	
Exhaust Steam and Drips	Buff	
Boiler Feed and Hot Water	Light terra cotta	
Cold Water	Olive	
Sprinkler	Pearl Gray	
Sprinkler Valves	Vermillion	
Waste	Light Lilac	
Heating Air Ducts	Pure Drab	
Heating Pipes	Black	
Gas Pipes	Medium Blue	
Blast Pipes	Light Seal Brown	
Air	Deep Sea Green	
Vacuum	Light Stone	
Drinking Water	Inside Pink	
MOLDING		
Electric Light 220 V.	Black	
Electric Light 110 V.	Dark terra cotta	
Patrol	Blue	
Power	Red	
Testing	Yellow Drab	
Fire Alarm	Vermillion	
Bells	Pea Green	

Machinery,N.Y.

Color Board giving List of Pipes and Wire Moldings with Name and Sample of Color

who put up the job; let them look after it. They have made all of the changes and put in the new connections and know practically the exact location of every valve and union in the system. The thing that the superintendent does not stop to consider is this: There is the possibility that the men who did the work may leave the employ of the compuany before new men have been on the job long enough to have learned all of the details of the system, the result of which might be, should an accident occur to, say a water line, considerable damage before anyone unfamiliar with the system could trace the line through a network of piping to a valve controlling the supply. With the different lines of piping painted distinctive colors, it would be a comparatively easy matter for anyone to trace the particular line to a valve, shut the valve and stop the flow of water before any great amount of damage had been done.

The best example of a color scheme for piping that has come under my notice, is the one in use at the Hawthorne plant of the Western Electric Co. They not only use distinctive colors for the different pipe lines throughout the plant, but they have extended the use of the color scheme to the moldings of the wiring system. Moreover, I noticed that there were "color-boards" upon the walls of the different buildings. The boards were about six or eight inches wide and probably eighteen inches long, and had a list of the lines of piping and moldings, the name of the color distinctive of each line of pipe or molding, and a small rectangle painted

with the particular color, as indicated in the accompanying illustration. Thus there was no possibility of a workman mistaking the line unless he was unable to read or was color-blind.

This color scheme is not standardized by any means, but it has the advantage of covering a wide range—more than most shops would need—and it was carefully worked out, the idea being to get colors that would "hold" and still not be so near alike in shade as to be confusing to the workmen.

Columbus, Ohio.　　　　　　　　　　　C. E. BLIVEN.

LUBRICANT FOR LATHE CENTERS

Until recently I have had considerable trouble with lathe centers, especially on small work when using high speed steel, as the work is revolved so fast that it is almost impossible to keep the centers from cutting. White lead is used by many to remedy this trouble, but I do not know what advantage white lead has over ordinary machine oil, unless it is the odor that is given off when the centers become heated, as this acts as a sort of warning. It may not be generally known that dry or powdered red-lead, mixed with a good grade of machine oil to about the consistency of cream, is an excellent lubricant for lathe centers. Since using this mixture I have never had a center cut, though they get very hot sometimes.

In order to test the efficiency of this lubricant as compared with a mixture of graphite and white lead composed of equal parts of these materials mixed with the best grade of machine oil, a piece of machinery steel 7/16 inch in diameter was placed between the lathe centers (which were lubricated with the graphite mixture) and revolved at a speed of 490 revolutions per minute for five minutes without stopping. After the piece had been revolving about two and a half minutes I could not bear my hand on it, and it was necessary to loosen the tail-stock spindle in order to give the lubricant a chance to work in between the bearing and center. At the end of four minutes the lubricant was smoking badly, and at the end of five the piece was taken out of the lathe, and the center examined. There was a slight burr thrown out around the hole, and by the aid of a glass it could be seen that considerable cutting action had taken place. The red lead and machine oil mixture was then used for lubricating the centers, with the result that when the piece was removed from the lathe at the end of five minutes, the hole did not show any cutting action whatever, but instead was very highly polished.

Geneva, N. Y.　　　　　　　　　　　ROY B. DEMING.

REPAIRING A LARGE CRANK-SHAFT

Some time ago I was called upon to repair the crank-shaft of a large pumping engine, which had a crank-pin broken as indicated in the engraving. This shaft was 18 feet long, 14 9/16 inches in diameter and had two cranks with pins 10½ inches in diameter by 10 inches long. It was a solid forging and weighed 10,880 pounds. The broken ends of the pin, attached to each web, were first drilled and planed off smooth. Each piece was then placed in a horizontal boring mill and

Machinery,N.Y.
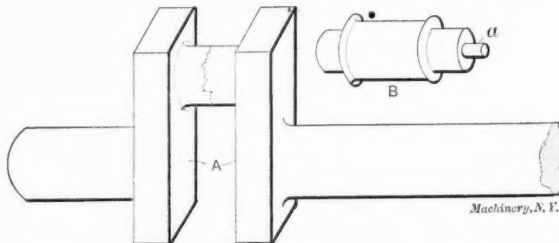
Large, Solid Crank-shaft which was broken as indicated, and repaired by Forcing a Pin into the Webs

roughly bored for the new pin which was to be fitted. The two faces A were then bolted together with the webs exactly in line, and placed in the mill a second time and bored, thus bringing the two holes absolutely in line. The webs, still bolted together, were next put on the planer and key-seated, and in this way both key-seats were also kept in perfect alignment. The pin was then forged and turned to the required

size, as shown at *B*. After it was finished in the lathe it was placed between the centers of the milling machine, and key-seats were cut into each end. A small part *a* was left on one end as shown, so that the pin could be turned in the lathe, and key-seated, without changing its position on the centers, thus keeping both key-seats and fittings in perfect alignment. Ninety tons was decided to be the proper pressure for forcing the pin into place, so, for an experiment, I used the formula and factor curve in the Data Sheet of August, 1903, by Stanley H. Moore, and found it to be correct. The formula given in this Data Sheet for determining the required pressure in tons is:

$$P = \frac{A D (P F)}{2}$$

where *P* equals pressure in tons, *A* equals area of fitting in square inches, *D* equals difference in diameter between plug and bore, *P F* equals pressure factor taken from the Data Sheet chart. The required pressure or the value of *P* was 90 tons, so transposing the formula and solving for *D* it became:

$$D = \frac{2 P}{A (P F)}$$

The holes in the webs for the new pin are 8 inches in diameter and 7 inches long, and by referring to the curve in the Data Sheet the value of *P F* for an 8-inch fitting was found to be 55, so, substituting the known values:

$$D = \frac{2 \times 90}{8 \times 3.1416 \times 7 \times 55} = 0.0186 \text{ inch.}$$

As the hole was counter-bored a short distance, thus cutting down the area, I increased the allowance for the fit to .019 inch, with the result that the pressure required to force the pin into place was approximately 90 tons. A hydraulic press was used for this purpose and the pin was forced into the lightest half of the crank first. After the shaft was tested in the lathe and found true, the ends of the pin, which were made 3/16 inch longer than the web thickness and hollowed out on the end, were riveted over into the countersink in the web. The bearings were then turned true, and the job was finished.   J. S. VAN PELT.

Augusta, Ga.

SUB-PRESS DIE FOR SPECIAL SPRINGS

The die described in this article was designed and made for the manufacture of a special spring used in connection with a heat regulator. This spring is of an irregular shape, and it was conceded that the only proper way to obtain these springs at a reasonable cost was through the medium of a punch and die. The first set of dies for this work was made in the ordinary way, without applying the sub-press principle, but these tools were soon found to be of little value, as the steel used in the springs was a special grade, hard to punch,
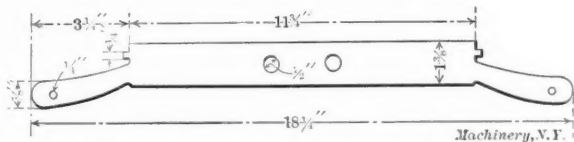

Fig. 1 Spring to be made in Sub-press Die in Fig. 2

and it was essential that the blanks must come from the press straight. The tools just mentioned would not leave the blank straight, and only a few could be punched before the die would be sheared and thereby rendered useless. The sub-press die described in the following was then designed, and, after being made and put in commission, proved satisfactory. A large number of blanks have already been punched, and the die is still in good condition. The spring shown in Fig. 1 is 18¼ inches long × 1⅜ inch wide on central part of the spring, and ⅞ inch wide on the wings; two ½-inch

holes are pierced in the central portion, and a ¼-inch hole in each wing. The thickness of the stock used in the spring is 0.055 inch. The width of the stock is equal to the length of the spring. The springs are cut from the end of the sheet to allow the stock to be fed through the die from front to back.

The die holder *A* shown in Fig. 2 is made of cast iron, finished on the top and bottom and on all bosses. The top is recessed to fit the die, which is 1 inch thick × 6¾ inches wide. More will be said about the die holder subsequently. The
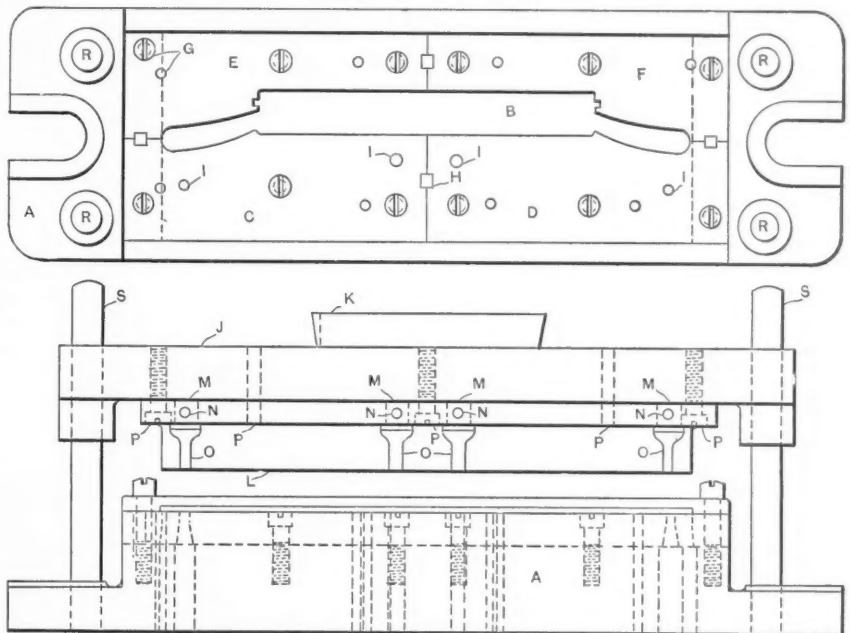
Fig. 2. Plan and Elevation of Sub-press Die for Making Spring shown in Fig. 1

die is a sectional die, consisting of four pieces; the two pieces *C* and *D* are 1 inch thick × 3¾ inches wide × 10¼ inches long; the two pieces *E* and *F* are 1 inch thick × 3½ inches wide × 10¼ inches long. The four pieces are finished on all sides, and are then placed in position on a surface plate, and the form of the spring is scribed on the surface. The stock is then removed to within 1/16 inch of the scribed line. The screw and dowel holes *G* are next drilled, there being three screw and two dowel holes in each of the four pieces. Each of the sections is next fitted tightly into its proper position in the die holder. The die holder is then placed under a drill press, and the holes are transferred into it from the sections. The screws used are ½-inch filister head cap screws; the dowels are made from ⅜-inch drill rod. With the die still in position, the four square key slots shown are laid out, one-half of the slot, which is ⅜ inch square, being in each section of the die. These keys serve to keep the four sections of the die in an accurate position, and thus prolong its life.

Before removing the sections, the templet of the spring is laid on the top surface of the die, and with a scriber the outline of the templet is scratched on the die. The sections are now removed and the keyways *H* are machined accurately to the lines, and the form of the spring, which has already been roughed out, is finished. The holes *I* to be pierced in the blank are now laid out, drilled, and reamed. This work finishes the machine work, and the sections are now ready to be hardened and tempered in the usual manner.

The reason for making this die in four sections was that the die, being 20½ inches long over all and the hole for the blank 18¼ inches × ⅞ inch, it was impossible to harden the die successfully in one piece. The sections being hardened, and the temper drawn, the edges of the sections are ground to a true surface, a very small amount of stock being removed.

When the bottoms of the sections have been ground, they are again placed in position in the die holder. With a scriber the hole for the blanking punch, as well as the four holes for the piercing punches, are scratched through the die on the die holder. The sections are then removed, and the stock in the die holder machined out to allow the blank and piercings to fall through. The sections of the die are then

replaced and fastened in place by the screws. The dowels are fitted and driven in place, as well as the square keys. The die is now ready to receive the punch shown in elevation in Fig. 2. This is made as follows: The punch holder J is of cast iron, machined on the top, bottom, and on the bosses. The dove-tail K is fitted to the ram of the press. The punch L is of tool steel 2½ inches thick, 6¾ inches wide, and 19½ inches long. This piece of steel is machined on all sides, and the punch fitted to the die. The holes for the piercing punches M are now transferred through the die into the base of the punch; after these holes are drilled and reamed, the punch is removed from the die. The set-screw holes N are drilled and tapped. The punches O are turned and fitted into the base of the blanking punch.

The punch is now ready to be fastened to the punch holder. In order to do this, the punch is placed in its working position in the die; the holder is then placed on top of the punch, and the bosses for the guide pins lined up in position. With a scriber the outline of the base of the punch is scratched on the punch holder; the punch is then removed and the screw and dowel holes P drilled and counter-bored in its base. The punch holder is then placed in position to receive the punch, which is placed on the holder between the lines already scratched, and the screw and dowel holes P are transferred through the punch to the holder. The holes are then tapped, and the punch holder is now ready to receive the punch, which, after being fastened by the screws, has the dowels fitted, and driven in place. This punch is not hardened, but left in its soft state, to allow for staking and cutting in the die in case it wears small.

The piercing punches O are now fitted; the shank is fitted to the punch base, and the opposite end to holes in the die. These punches are then hardened and tempered, after which they are placed in position in the blanking punch, and fastened by set-screws N. The punch is now complete, and placed in working position.

The punch and die is then fastened on a horizontal boring mill, and the four guide pin holes R are bored, great care being taken to have these holes exactly in line. After boring, the holes are reamed, using a lining reamer, which insures perfect alignment. The guide pins S are next turned to 1.015 inch diameter, and 11¾ inches long. After turning, the pins are hardened and tempered, and then ground the entire length. The ends fitting the die holder are a driving fit, the remaining part being a sliding fit in the holes in the punch holder. The punch and die are then ground on the cutting surfaces, and, after driving the guide pins in position, the punch is placed on the pins and gently lowered to the face of the die, to test the accuracy of the tools. If the punch enters the die equally free on all sides, and the piercing punches are found to be in line with the holes in the die, the punch and die are pronounced ready for use.

This tool proved satisfactory from the start, and nearly 25,000 springs have been blanked to date, the blanking punch having been staked and cut in once, which operation required about one hour's time. NOTBOH.

ISOMETRIC PERSPECTIVE

I must take exception to one or two statements of Mr. Honey in MACHINERY for August, 1907, as regards isometric perspective. In the first place, "perspective" is not in this connection "an erroneous expression." According to the first definition in the Standard dictionary, perspective is "the art or theory of representing, by a drawing made on a flat surface, solid objects or surfaces seen as not lying in that surface; delineation of objects as they appear to the eye; specifically, in mathematics, a branch of projective geometry."

Isometric projection certainly fills this bill as far as the first part of the definition is concerned; and if we consider objects as they appear to the eye, their appearance depends entirely on the point of view. In the so-called "painter's" or "diminishing" perspective, the object appears to no two observers the same. It just happens that in isometric perspective or projection, the point of view is an unusual one—namely, one in a line passing through the object at an equal angle to all three co-ordinate axes; an angle best expressed in

familiar language by saying that it corresponds to that of the greatest diagonal of a cube. If a cube be so tilted that the line of sight passes through this greatest diagonal, the outline presented will be a regular hexagon, with the nearest corner of the cube in the center of the circumscribed circle. This is the exact isometric projection of the cube. A photograph taken of a cube with this greatest diagonal in the axial line of the camera lenses would exactly coincide with an isometric perspective of the same cube, care being taken that the scale was the same.

The isometric representation is by no means "distorted." The fact that such a body as a cube, which is symmetrical with regard to every axis, is reproduced isometrically as a perfect-
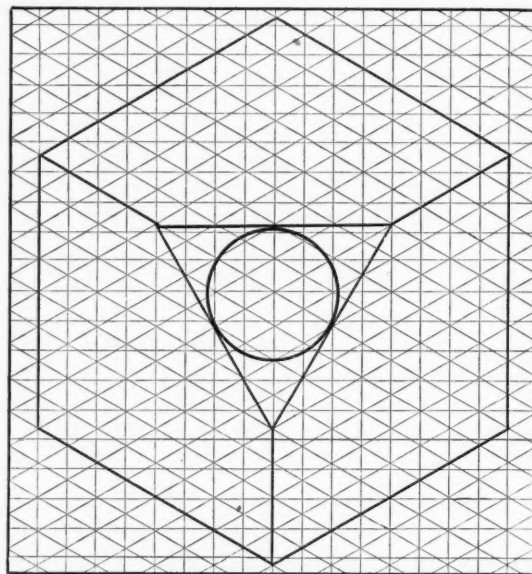

Fig. 1. Example showing that Objects are not distorted when drawn in Isometric Projection

ly symmetrical drawing, whereas the "diminishing" or "artistic" perspective or projection of the same cube may have no two sides or angles alike, shows that the isometric projection is in fact the only one which is *not* distorted.

It is also not strictly correct to say that "whenever it is necessary to represent circles in this kind of projection, the drawing of ellipses is unavoidable in whatever position the object is placed." It depends entirely on the object. If its shape be such that every circular outline therein lies in one of the co-ordinate planes, ellipses will be necessary whenever the object is supposed to be viewed along the line of sight above referred to—namely, at equal angles to all the co-ordinate axes; and the major and minor axes of such ellipses
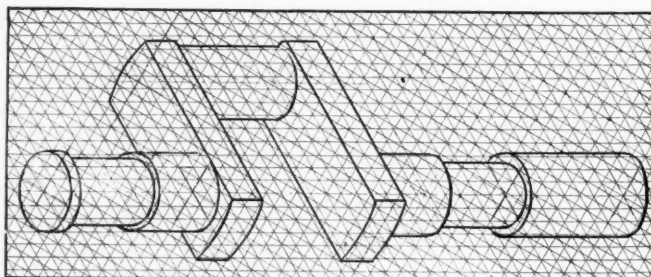
Fig. 2. A Crank-shaft shown in Isometric Projection

will bear to each other the proportion of 1 to $\sqrt{3} = 1 : 1.732$; that is, considering 1 as the diameter of any circle, the major and minor axes of the corresponding ellipse, projected isometrically in the same manner, are respectively 1.225 and 0.707. Most other circles, not lying in these co-ordinate planes, as, for instance, in the faces of a cube, will also be ellipses. But if we have a circle lying in a plane at right angles to the greatest diagonal of the cube, and view it along this diagonal, not only will it appear as a circle; but it can appear as nothing else. Further, the isometrical projection of a sphere cannot be anything else than a circular outline, no matter from what point of view, in what plane projected, or from what distance viewed.

It is also not true that "this distortion increases with the increase of the dimensions of the object"; because in the first

place there is no distortion; in the second, the isometric projection being supposed to be taken with rays of light that are parallel to each other, that is, taken at an infinite distance from the object, dimensions have nothing to do with the case; it is a matter of proportion only.

Fig. 1 shows an isometrical projection of a cube projected at right angles to its greatest diagonal, and with a circle inscribed in the triangle produced by this section.

In this connection allow me to say that the popularization of isometric drawing in Germany and America is due to me, it having been facilitated by the isometrically-ruled paper patented by me in Germany in 1902, and a sheet of which was sent, for the purpose of patenting it, to the American publishers who are now pushing the system. As far as I know, no patent was applied for, but some of the material used in an American pamphlet on the subject is taken, without credit, from my *"Leitfaden für die Isometrische Projektion,"* published by Gebr. Jänecke, Hanover, in 1902. One of the illustrations (shown in Fig. 2) used by the American publishers for advertising purposes, over some such inscription as "Can you draw this?" is Fig. 132 of my German book. I send you my original drawing. Although nothing has been paid me for the use of my material, I like to have the satisfaction of being properly credited.   ROBERT GRIMSHAW.

Dresden, Germany.

FORMULA FOR MILLING V-SHAPED GROOVES WITH INCLINED TOP AND BOTTOM

The accompanying formula and table will be found very useful in making patterns and broaches for brackets, such as are used on bicycle lamps, automobile speed indicators, etc. These brackets, in order to fit into each other, must have the top and bottom of the teeth inclined at the same angle, as shown by the lines KA and KG in the engraving.
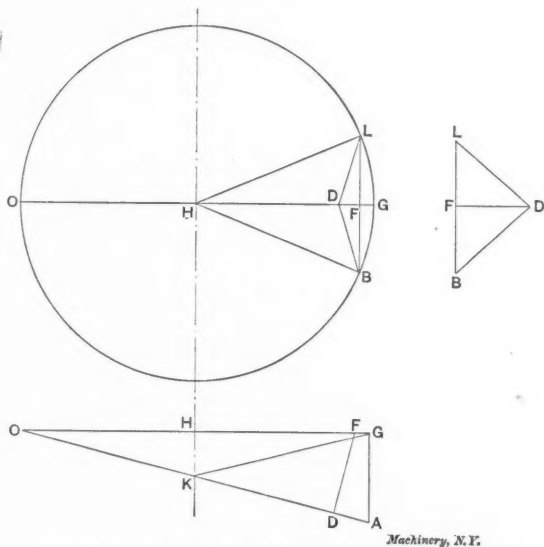

Diagram for Deriving Formula for Setting Index-head for Cutting V-shaped Grooves

Assume that the number of teeth is N, that the cutter angle LDB is given, and that the radius HG equals 1. The angle LHB, which is the angle of one tooth, is bisected by the radius HG. Draw LF perpendicular to OG. The line KA represents the bottom of the tooth; the plane in which the angle of the cutter for milling the tooth must be measured is perpendicular to KA. Assume, therefore, that the angle is measured in a plane FD. (See lower view of engraving.)

$$\text{Angle } LHB = \frac{360 \text{ degrees}}{N}$$

Since HG bisects angle LHB,

$$\text{Angle } LHG = \frac{360 \text{ degrees}}{2N} \text{ and } LF = \sin \frac{360°}{2N}.$$

The triangle LFD shown at the right in the engraving is in a plane perpendicular to OA. In this triangle

$$FD = LF \times \cot LDF = \sin \frac{360°}{2N} \times \cot LDF.$$

But FD also lies in the plane containing the right triangle ODF.

$$OF = OH + HF = 1 + HF; \text{ but } HF = \cos \frac{360°}{2N},$$

consequently

$$OF = 1 + \cos \frac{360°}{2N}$$

and

$$\cos OFD = \frac{FD}{OF} = \frac{\sin \dfrac{360°}{2N} \times \cot LDF}{1 + \cos \dfrac{360°}{2N}}.$$

The angle OFD equals the angle OAG, or the angle to which to set the index head.

TABLE OF ANGLES FOR SETTING INDEX HEAD WHEN MILLING V-SHAPED GROOVES

No. of Teeth	Included Angle of Cutter		No. of Teeth	Included Angle of Cutter	
	60°	90°		60°	90°
10	74° 5′	80° 53′	31	84° 57′	87° 5′
11	75 35	81 53	32	85 6	87 11
12	76 50	82 26	33	85 16	87 16
13	77 52	83 2	34	85 25	87 21
14	78 45	83 32	35	85 32	87 26
15	79 31	83 58	36	85 40	87 30
16	80 11	84 21	37	85 47	87 34
17	80 46	84 41	38	85 54	87 38
18	81 17	84 59	39	86 0	87 42
19	81 45	85 15	40	86 6	87 45
20	82 10	85 29	41	86 12	87 48
21	82 34	85 42	42	86 17	87 51
22	82 53	85 54	43	86 22	87 54
23	83 12	86 5	44	86 27	87 57
24	83 29	86 15	45	86 32	88 0
25	83 45	86 24	46	86 37	88 3
26	84 1	86 32	47	86 41	88 5
27	84 13	86 39	48	86 45	88 8
28	84 25	86 46	49	86 49	88 10
29	84 37	86 53	50	86 53	88 12
30	84 47	86 59	..	.. ..	.. ..

The formula above expressed in words would be:

The cosine of the angle to which to set the index head equals the sine of one-half of the tooth angle, multiplied by the cotangent of one-half of the cutter angle; this product divided by 1 plus the cosine of one-half the tooth angle.

Belvidere, Ill.   IRVING BANWELL.

CAM-OPERATED PRINTING PRESS MECHANISM

It was desired, on a printing press, to remove the printed sheets from the cylinder at the rate of fifty a minute. The cylinder was 6 inches in diameter and rolled back and forth over the type bed. The type bed also moved back and forth the same distance as the cylinder, one moving forward while the other moved backward. The sheets extended two-thirds around the cylinder and were held by grippers at the front edge. When the cylinder reach a position in which the front edge of the sheet was at the top—after having made one complete revolution—the sheet was to be taken off the cylinder and carried 23 inches horizontally. The object of this article is to describe the means by which this was accomplished.

The movement of the press will be understood from Fig. 1. The crank A drives the carriage or type bed by means of pitman B acting on bracket C. Bracket D is bolted to the under side of the carriage, and at its lower end engages with lever E. This lever is pivoted at its center F, and its upper end engages the cylinder, thus securing the same movement of type bed and cylinder, but, as stated above, in opposite directions. The sheet is fed to the cylinder in position G and is gripped for removal at the take-off position H. J represents the extreme throw of the cylinder forward.

An interesting point to be noted here is the surface speed of this cylinder. When near the take-off position the cylin-

der center moves approximately one inch for each 10-degrees revolution of the crank. If it had simply a rolling motion, the same as a cart wheel, a point on the top of the cylinder would move 2 inches in this time. Being geared to the carriage and the carriage moving backward an inch—the same distance as the cylinder center moves forward—causes the point on the top of the cylinder to move another inch, or 3 inches in all. The paper is therefore unwound from the cylinder at this rate of speed or about 9 feet per second, and mechanism had to be designed to take it as fast.

The figures 1, 2 and 3 represent the position of parts of the mechanism after a 10-, 20- and 30-degree revolution of the crank from the take-off position 0. The movement of the take-off is as follows: K represents a pair of racks which slide in ways and mesh with gears L. These racks are connected by rods which carry the grippers M. The pinions N

base equal to one member of the proportion and the altitude equal to the other and draw the hypothenuse. A proportional to any given dimension may be found by laying off the given dimension from 0 on the horizontal and erecting a perpendicular to the hypothenuse, which will be the required dimension.

Scraps of tracing cloth are very useful in plotting out movements on the drawing board. The laying out of cams is made easy by having the cam shape on the cloth in pencil; the cam may then be given the same motion as in the machine, and the shape altered to produce the required movement. This, of course, only applies to face cams.

The points 1, 2 and 3 were the most essential in the design of the cam, and were laid off along the center line of the connection R at 1', 2' and 3'. This was done by means of the strip of cloth as explained above. It is evident that as connec-

Figs. 1 and 2. Lay-out of Cam and Cam Motions for Printing Press

are fastened to the same shaft as L and mesh with the stationary racks O. This shaft is journaled and has a horizontal movement of 7¼ inches by means of the connections P and lever Q. Lever Q is reciprocated by means of the cam on the crank shaft through connection R. The driving of rack K is another variation of the cart-wheel principle. The distance the rack K will move for each inch of movement of the center of the gear and pinion, equals the ratio of the radius of the pinion to the sum of the radii of the pinion and gear. The pinion and gear are 2¼ and 5 inches respectively. The ratio is therefore 1⅛ to 3⅝.

Since most draftsmen do not have proportional dividers, and as it often happens that they cannot be adjusted fine enough even when the draftsman does have them, a convenient way in which to find proportional dimensions is shown in Fig. 2. Make a right-angled triangle having the

tion R moved out, its end S would drop, thus raising the roller slightly at each ten degrees of revolution of the cam. The exact positions of the roller are indicated by short lines at 1", 2" and 3".

Spaces of ten degrees were laid off about the center T either side of the center line T0, with the exception of 70 degrees "dead" time at U. Circles from the points 1', 2' and 3' were scribed about the center T to their respective radial lines, allowing for the increments at 1", 2" and 3". Circles were drawn with these centers the size of the cam roller, and curves were drawn tangent, thus giving the contour of the cam walls.

When this most important part of the cam was determined, the remaining ten degrees spaces on the upper half of the cam were twelve in number. The space along the center line from 3' to V was divided into twelve parts decreasing in

size so as to produce a gradual movement down to the "dead" part of the cam. When these points were described about the center T onto their respective ten degree radial lines, the cam walls were drawn in.

The lower half of the cam from U to W was simply to produce a return movement. On the center line TW the movements for this part of the cam are shown. The 5⅜ inch of throw from V to W was divided into thirteen parts—the number of ten degree spaces—which were graduated so as to start the roller slowly from the inactive portion of the cam, increasing to obtain the greatest movement at the center, and slowing down again for the reversal of motion. The ten degrees from W to 0 was to allow an opportunity for a better curve to reverse the motion. The movement of the cam from 0 to W gives ¼ inch movement along the center line. This causes the take-off at the cylinder to run by and reverse its motion and be on the return stroke when it grasps the paper. In the portion of the cam from 3" to U the slight variation due to the dropping of the connection at S was neglected as being of no importance. The same was true regarding the lower part of the cam from U to 0. Both these portions of the cam might have been laid out according to either the gravity, simple harmonic or elliptic formulas. The eye proved to be a sufficient guide in this case. It is good practice to lay off the increments along the center line as shown in the diagram. The relative movement or time of the cam may then be seen at a glance.

This cam was cut in the lathe, a former having first been filed up. By putting the cam and former on an arbor, removing the screw from the cross slide and putting a weight on the slide to keep the tool against the former, the cam was roughed out. A roller of slightly smaller diameter than the finished size was fitted to the tool to bear on the former. The cutting edge of the tool was kept even with this roller. A finishing cut was taken with a rather odd tool. It consisted of a piece of tool steel the same diameter as the roller to be used, squared on one end to fit the tool-post. This piece was left round for a sufficient length to bear on the former. At the end, teeth were cut in it the same as a file, and the tool, when hardened, was ground to size. After taking a finishing cut with this tool the cam and roller were a fine fit.

New York City.　　　　　　　　David J. Walsh.

EFFICIENT TYPE OF BLANKING AND FORMING DIE

A novel design of die which will appeal to progressive manufacturers, as well as die-makers, is shown in the accompanying illustration. Ordinarily the blank is punched out and then put through the successive bending operations until it is completed. The type of die shown herewith, which
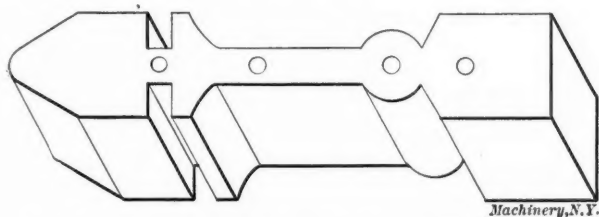
Fig. 1. A Die in which the Outer Edges are used for Shearing the Metal when Blanking

can be employed on most classes of work, does not cut out the blank, but trims off the metal on the outside, leaving the blank attached to the strip until the last bending operation is completed, when it is cut off. All these operations are successive. While the bending operation is taking place, piercing and blanking punches are preparing another blank. The die proper, which is shown in Fig. 1, does not look familiar to the average die-maker, as he is accustomed to dies having holes cut through corresponding to the shape of the piece to be blanked. In this case, the outside of the die is used as a cutting edge for shearing the stock to the required shape.

The first thing to be done when constructing such a die would be to develop or determine the shape of the blank before it is bent to shape. The best and surest way known

to the writer is to carefully ascertain the shape as near as possible and then cut out two blanks, by hand, exactly alike, marking each with the same symbol. One of these blanks is then bent to the required shape, and if the piece is too long or too short after all the bends are made, the duplicate can be referred to when making another pair of blanks with the required changes. By following this method of always making two blanks, then bending one and retaining the other to refer to until the desired shape is obtained, we have, finally, a straight blank which is useful for laying out the blanking die. The bending die should almost invariably be made before the blanking die, as it is much easier to change the shape of the templet, than to change the blanking
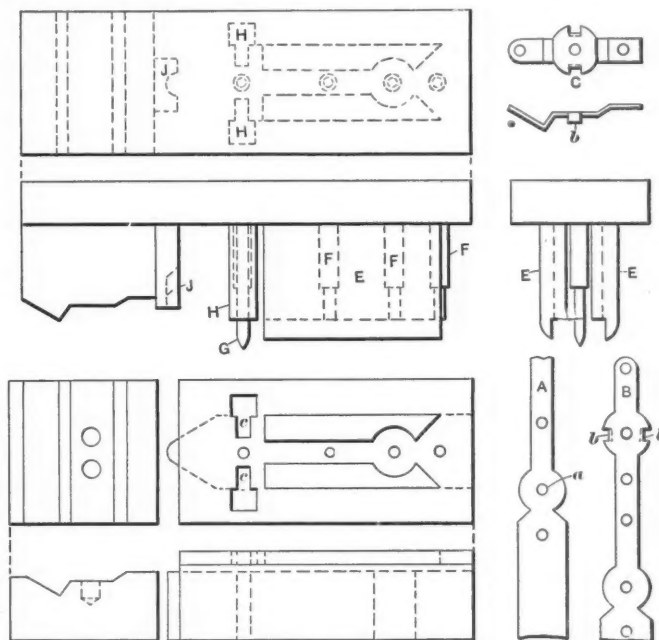

Fig. 2. Diagrammatical View of Blanking and Forming Die for Producing the Piece shown at C

die. After the bending dies are completed so that the finished blank is correct, the duplicate templet can be used to lay out the blanking die. This is almost universally made by cutting a hole the shape of the templet, through the die and filing it to size. This method means that we must make a blanking die and punch and two or three bending dies and punches, which also means that there are to be two or three presses in use. Compare, mentally, the cost of producing 1,000 blanks made under such conditions, with the cost of producing the same number made with one die and with one press that produces a finished blank at each stroke. When the nature of the work will allow slight variations on the outside of the blank, there is no comparison whatever between this type and the older style of die.

Referring to Fig. 2, A and B show the stock after the first and second blanking and piercing operations, respectively, and the finished piece is shown at C. During the first operation the piece is blanked by the punches E and pierced by the three punches F. As the blank is moved along for the second operation, it is located by the pilot-pin G which enters the hole a. The lugs b are formed by the punches H on either side, after which the piece is ejected by spring-pins located at c, so that it may be fed along. The blank is then cut off by the punch J.

It might be well to add that with clever designing, this die might be advantageously used for work requiring more accuracy than that here illustrated.

Pittsfield, Mass.　　　　　　　　F. E. Shailor.

* * *

The *Mechanical World* gives an account of the amount of money expended on aerial navigation by various governments during 1908. In Germany, the amount of public money spent was about $660,000. The French government spent $235,000, and Austria Hungary $27,000; Great Britain expended about $25,000. Besides the large public expenditure in Germany, over $1,300,000 was privately subscribed in that country in connection with the Count Zeppelin fund.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

TO TURN SOFT RUBBER

Mount the rubber roll on a wooden mandrel, if the size of the hole will permit, or on an iron mandrel if the hole is of small dimension. Drive the work at about the same speed as for finishing brass. For a turning tool use a worn-out half-round file, without drawing the temper. Grind out nearly all the teeth but leave a sharp burr on the cutting edge. This saw-tooth edge is what does the work. Give the tool plenty of clearance. E. B. GAFKEY.

Lakewood, Ohio.

BELT FASTENER

The accompanying sketch shows a belt fastener, attached to a 3-inch double belt, that will more than equal the strength of the belt itself, and last as long. It is made of a common T-hinge of the proper width, which is secured to the belt by eight 3/16-inch copper rivets, as shown. The pin hole
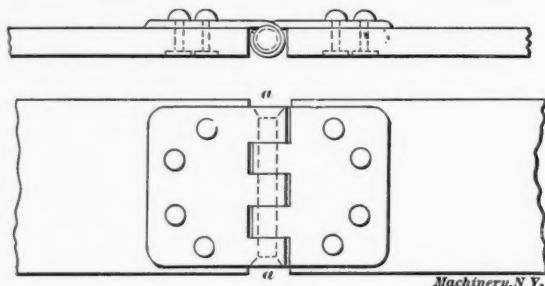
should be countersunk in the ends as at a, and the edges of the hinge nicely rounded. A brass pin should be inserted in place of the steel one and riveted over on the ends. As will be seen, the knuckle part of the hinge comes between the ends of the belt. On wide belts, two or three hinges may be used. A. I. LINSLEY.

Cleveland, Ohio.

SPACER FOR LETTERING

A spacer for giving the proper height to the lettering on the body of a drawing is shown in the engraving. As will be seen it is made by fastening together, with rubber bands, two flattened pencils. As a rule these letters are about 3/32 inch
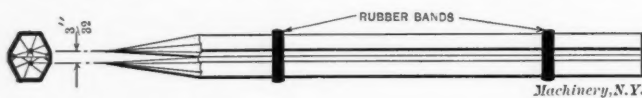
high, but if higher or lower spaces are desired, a set of two or three spacers could easily be made which would answer all the requirements of a drafting-room. The leads are easily sharpened by simply removing the bands.

Three Rivers, Mich. E. G. PETERSON.

TO PREVENT THE BREAKAGE OF INCANDESCENT LIGHT GLOBES

Many readers of MACHINERY have doubtless been annoyed by the continual breakage of incandescent light globes hung near some rapidly moving belt. Of all the electrical phenomena whose exact nature we really know so little about, none manifests itself to us more frequently than the static charge residing on the surface of a moving belt. An observing person will notice that the filament of a lamp in proximity to a charged belt is distorted until it touches the glass, even though no spark is visible. Now, when the current is turned on, as soon as the filament becomes incandescent the glass cracks and the lamp is on the retired list. Here is a simple preventative: Attach to the lamp, in the ordinary manner, any one of the numerous wire protectors on the market. To this protector fasten a fine wire, say number 16 bell wire, and run it to an overhead I-beam, water pipe, or other metal body that is grounded. Through this path the static charge passes away without affecting the lamp. It is understood, of course, that the protector is insulated from the lamp circuit by being fastened to the insulated socket. DONALD A. HAMPSON.

Middletown, N. Y.

DEVICE FOR ROLLING TIN-PLATE TUBES

A rush order came to my department for several thousand tin-plate steam heater floor tubes. The shop rollers were too large in diameter for the job, and the usual method of manufacture, that is, bending the pieces of tin-plate around an iron rod in a groove in the creasing stake, was too slow. Consequently, I made an appliance similar to the one shown in the illustration. The device consists of a cast iron block A, which
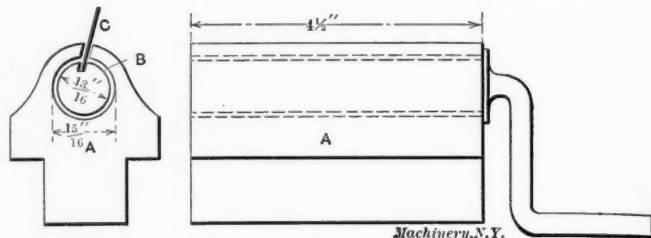

is bored to receive the roller B, having a slot throughout its length, as shown, which holds the metal plate when the crank is turned and the roll is being formed. When one edge of the plate C is inserted in the slot in the roller, the crank is turned two or three times, when the roller and tube can be withdrawn. With this simple tool, the output was increased to 500 per hour, as against 50 per hour with the creasing stake. Manchester, England. T. ILES.

ATTACHMENT FOR THE DRAWING-BOARD

In laying out work, it is often necessary to locate a center or some other point beyond the scope of the average sized drafting-board. The accompanying sketch illustrates a simple
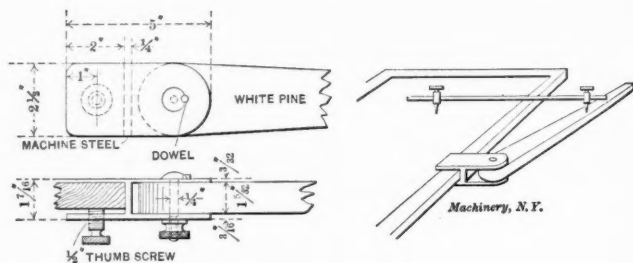
device that has been found to meet the requirements when such occasion arises. If the attachment is made according to the dimensions given, it will fit any board up to 1⅛ inch in thickness. W. L. VAN NESS.

Toledo, Ohio.

TWO TYPES OF BACK TOOL REST

Fig. 1 illustrates a very poor back tool rest which may be seen on some new screw machines. The tool lacks sup-
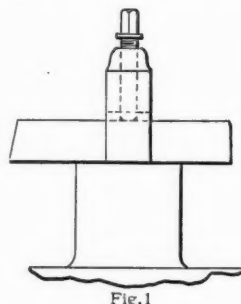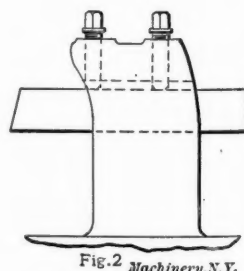

port, breakages are frequent, and the efficiency is thereby greatly diminished. Fig. 2 shows what these machines need—a rigid tool rest. F. RATTEK.

Brighton, Mass.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

CHAMPION DOUBLE BACK-GEARED LATHE AND IMPROVED GEAR BOX

In Fig. 1 is shown the head-stock end of an engine lathe built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O. The special feature of the design lies in the use of a three-step cone for a high power belt, which may be connected with the spindle either directly or through double back gears. The throwing in of the back gears or the changing from one back gear ratio to the other may be effected from the front of the machine by the use of conveniently placed levers and handles. The drive will be understood from a study of the half-tone engravings, Figs. 1 and 2, and the line engraving, Fig. 3, which shows the mechanism.

The cone pulley A has driven into it a sleeve B, having pinion teeth cut in its outer end. A second gear, C, is driven onto a seat turned just behind the flange. Gears B and C mesh with corresponding gears D and E, which are normally free to revolve on back gear quill F. The latter is supported by shaft G, which passes through the length of the head-stock and bears at opposite ends in the eccentric hubs of levers H, which are journaled in bearings in the head-stock casting. The outer ends of levers H are connected by bar J, which may be reached from the front of the machine. By swinging this bar J, the eccentric hubs of levers H throw the back gear
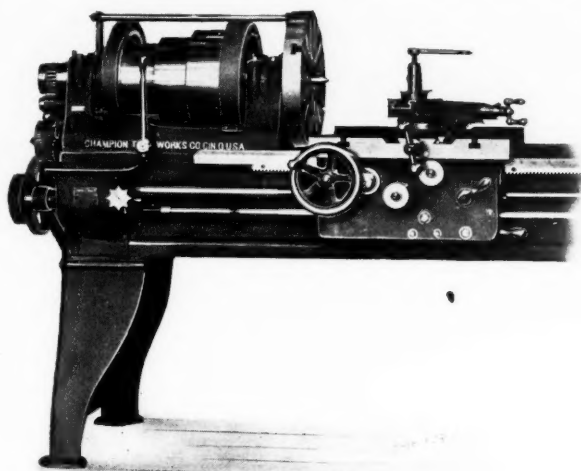
Fig. 1. Double Back-geared Head-stock for Champion Lathe

quill forward or backward, so that gears D and E are thrown in mesh with gears B and C, while the pinion formed on quill F is thrown into engagement with driving gear K, keyed fast to the spindle.

As stated, gears D and E normally revolve freely on quill F. The hubs of these gears have key slots cut in them, and are recessed on their inner hubs to furnish a clearance space for key L, which may be shifted axially in a cross slot in G by means of a bar M pinned to the external sliding collar N. In the central position, when L is resting in the recesses of the hubs of D and E, both these gears are disconnected from the shaft. When sleeve N, and with it M and L, is moved to the right or left, the key is forced into one of the opposing pairs of slots in the hubs of the gears D or E. By this means the two back gear speeds are obtained. Sliding collar N is operated by a yoke and rock-shaft provided with a handle, shown at the front of the head-stock in Fig 1.

Great belt power is obtained by this drive. The smallest step is 8¼ inches in diameter for a 3½-inch belt, and the largest is 11½ inches in diameter. The operator has perfect control of the back gears without moving from his position, and may make changes from single back gear to double back gear, or *vice versa*, without stopping the counter-shaft. This double back gear does not interfere with the driving of work in which the spindle is directly connected with the cone. The speeds are positive, and no friction or other connections are used, clutches being relied on for the various changes. This

double back-geared drive is an invention of Mr. John C. Pflanzer, superintendent of the shops of the makers. It is applicable to 16-inch lathes and larger.

The new feed box is shown applied to the lathe in Fig. 4. The gearing connecting the spindle and the gear box is exceptionally well guarded, as shown, standing comparison in this particular with the lathe of any other American maker. The guard has a spring catch which may be released to swing
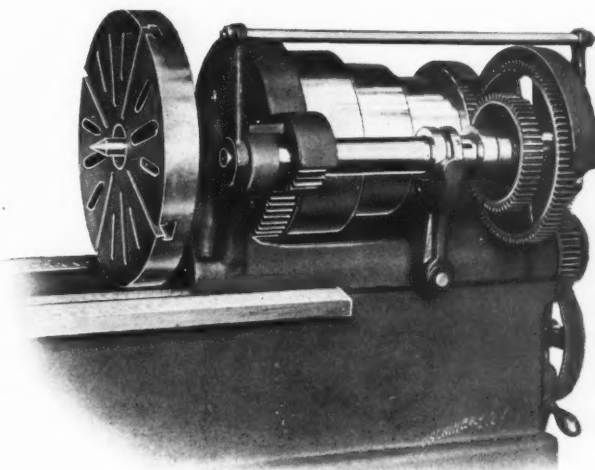
Fig. 2. Rear View of Head-stock, showing Arrangement of Double Gearing

it back for oiling the gear bearings. If desired, it may be easily lifted off the machine entirely. The use of a substantial guard is made possible by the fact that a large number of screw cutting and feed changes are provided by the gear box, without requiring the removal or replacing of any change gears. The quick-change gear mechanism gives forty different threads or feeds in all.

Provision is made for reversing the feed by the lever at the end of the head-stock in the usual way. A double train of gearing is provided between the spindle and the gear box, either side of which may be thrown into action by a push pin,
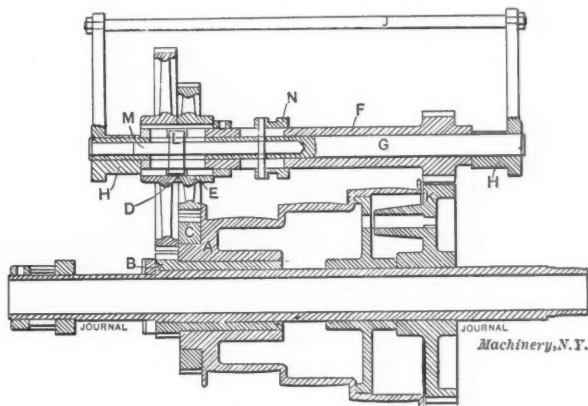
Fig. 3. Plan View of Driving Mechanism

thus giving two rates of speed to the driving shaft of the feed mechanism. This driving shaft has formed on it a pinion extending the full length of the feed box, meshing with an idler carried on a swinging arm, so that it may be adjusted to engage with either one of a cone of eight gears on the variable speed shaft above it. This construction is, of course, a familiar one. The variable speed shaft is in turn geared to an intermediate shaft, which is connected with the lead-screw by a cone of three gears. A sliding key operated by the vertical knob shown at the right-hand end of the feed box, throws either one of these three sets of gears into action. These have ratios of 2 to 1, 1 to 1, and 1 to 2 respectively. The knob for making these changes is retained in each position by a ball forced by a spring into a depression placed opposite

each one of the three stopping points. This prevents the shifting key from working out of position except when the knob is turned by the operator.

There are thus forty-eight combinations possible, derived from the two changes controlled by the pull pin in the outside gearing connections, the eight changes furnished by the swinging idler and the main cone of gears, and the three changes controlled by the vertical knob. Of these forty-eight combinations, forty are non-duplicates, giving that number of separate thread pitches without change of gearing. Provision is made in the connection between the head-stock and gear box for change gears for odd or fractional pitches as required. The forty threads available range from 2 to 56 per inch, including 11½. The forty non-duplicating feeds give 3½ times the number of turns per inch for the corresponding thread.

The lead-screw is driven from the lead-screw shaft in the gear box by a clutch, which may be thrown out if desired when the rod feed is in use. The latter is connected with the feed-screw shaft by gearing inside the box. The splined feed rod
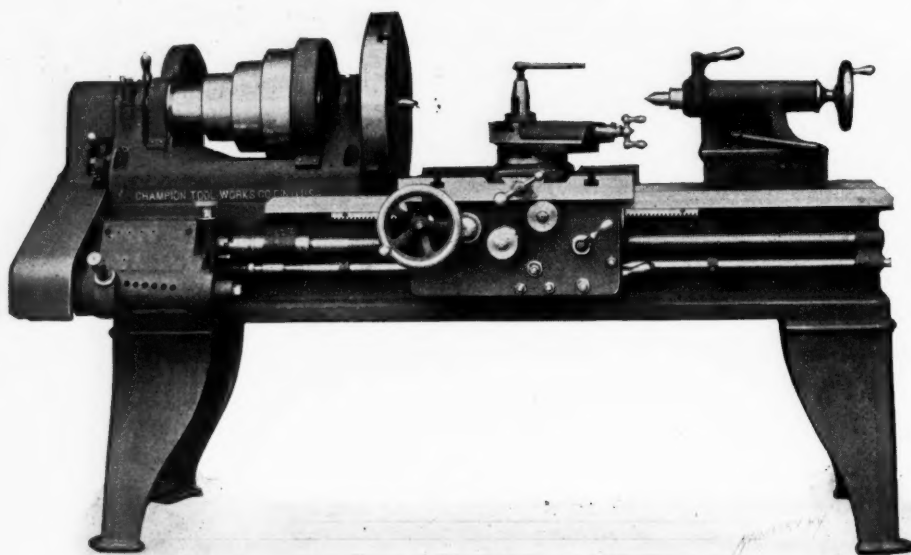

Fig. 4. Sixteen-inch Champion Lathe with Gear Box Mechanism giving Forty Changes

has a provision for axial movement against the pressure of springs in either direction. These springs hold it normally in central position, where suitable clutch teeth engage with corresponding internal teeth on the loose gear by which it is driven from the lead-screw shaft. Stop collars are provided as shown, on each side of the carriage. When the automatic feed forces the carriage against either of the stop collars in either direction, the feed rod is thereby shifted longitudinally and the clutch is thrown out of engagement, stopping the feed. When the carriage is returned by hand to the starting point again, after releasing the friction in the apron, the spring automatically throws the splined rod back to the central position, so that the feed rod clutch is again in engagement.

The pinion in the apron may be withdrawn when chasing threads, and provision is made in the apron feed reverse for interlocking with the lead-screw half-nut, so that the rod and screw feeds cannot be engaged at the same time. The rack pinion has an inside bearing, so that the apron is virtually of the double construction so far as this vital feature is concerned. The gears and longitudinal feeds are controlled by independent frictions.

The compound rest slides have taper gibs, and the swivel is graduated in degrees. Both compound rest and cross feed screws have dials graduated in thousandths. The carriage has a chasing dial connected with the lead-screw, which permits the cutting of threads without reversing the spindle. By its use the operator is informed of the proper time to throw

in the half-nut. This permits using the two belts of the counter-shaft for giving two speeds in one direction, so that with the single back-geared four-step cone drive, sixteen spindle speeds are obtainable or, similarly, eighteen speeds are obtainable with the head-stock mechanism shown in Figs. 1, 2, and 3.

The quick change gear device is applicable to the 12, 14, 16 and 18-inch lathes manufactured by the Champion Tool Works Co. It is the invention of Mr. William Donaldson, secretary and designer of the firm. The lathe shown in Fig. 1 has a simpler feed gearing, which will be furnished if desired by the customer. With it three changes of pitch or feed are obtainable without altering the change gears.

BROWN & SHARPE NO. 12 PLAIN GRINDING MACHINE

The plain grinding machine illustrated herewith is built by the Brown & Sharpe Mfg. Co., Providence, R. I. In the broad lines of its design it resembles the larger plain machines of the same make, being intended for rapid and accurate manufacturing of such parts as spindles, shafts, rolls and other work (either straight or taper) capable of being finished on dead centers. It will take work up to 8 inches in diameter and 36 inches long, being thus intermediate between the makers' No. 11 and No. 13 plain grinding machines; the former of these is of different design, built especially for small work. The No. 12, which is here under consideration, will take in the major portion of the grinding work of the ordinary machine shop, and handle it with a rapidity and accuracy corresponding to the highest present attainments in the art of grinding.

General Construction of the Machine

The base supports the entire mechanism on a single casting; it rests on the floor or foundation on a three point bearing, one at either end of the front view of the machine in Fig. 1,
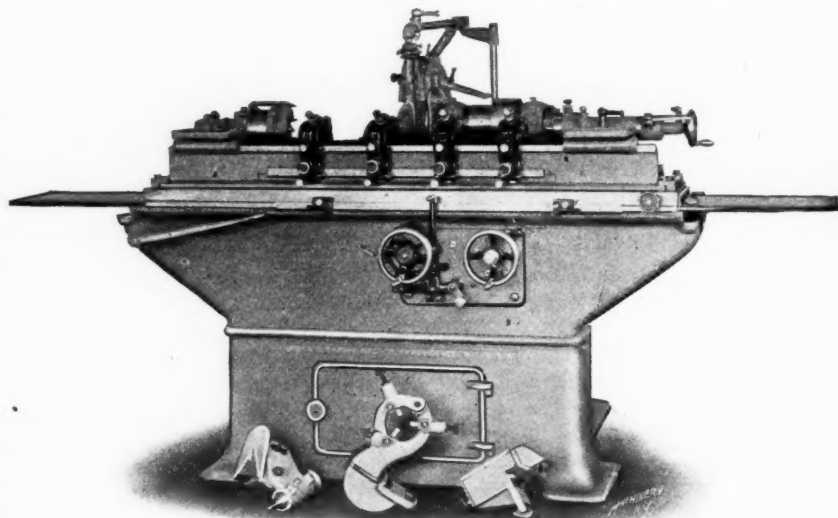

Fig. 1. Brown & Sharpe No. 12 Plain Grinding Machine

and the other at the center of the base in Fig. 2. This three-point bearing gives assurance that the machine will always be supported under the same conditions as when it was planed and scraped, so that the original accuracy of workmanship is preserved. While this compensates for any unevenness in the floor, a solid, steady support is desirable, and a cement foundation will be found a valuable factor in increasing the output in manufacturing work. The base is hollow, and is fitted with

shelves to receive small tools and accessories. A tank and pump for wet grinding are also located inside the base. The pump is of the centrifugal type, with bearings above the water line. It is self priming, and no packing is required. (See Fig. 3.) A complete set of water guards and pans protects the floor and returns the waste to the settling tank and pump. On the carriage is mounted the swivel table, carrying the head- and foot-stocks, to provide for grinding tapers. A quick adjustment and graduated scale is provided for obtain-
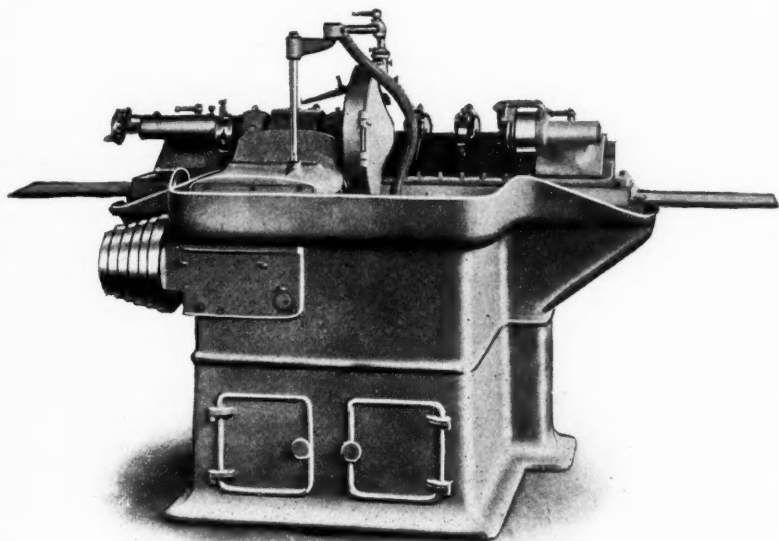
Fig. 2. Rear View of Grinding Machine

ing the taper desired. The head- and foot-stocks are adjustable on ways on the inclined face on the swivel table. These ways are protected from the water by adjustable guards. The universal back-rests furnished with the machine for supporting long slender work or splined shafts, are supported on independent ways of their own on the vertical front face of the swivel table, as is plainly shown in Fig. 1. The head- and foot-stocks are adequately protected from water and grit. The foot-stock has permanently attached a device for holding a carbon point in truing the wheel, which can thus be done without removing the work.

Improvements in the Cross-feed Mechanism

Fig. 3 shows a section through the wheel spindle, and illustrates an improvement in construction which makes possible the rapid traverse of the wheel spindle slide. The cross adjustment is effected by a vertical pinion on shaft A, meshing with rack B, which is firmly screwed to the slide. To A is pinned the clutch C, which engages a corresponding clutch member screwed and doweled to worm-wheel D, which in turn is operated by worm E controlled from the cross-feed hand-wheel at the front of the machine. By turning the short lever shown below and between the two hand-wheels on the front of the bed in Fig. 1, cam F is rocked into the position shown in Fig. 3, thus raising shaft A and disengaging clutch C. leaving the slide free from worm-wheel D and from connection with the cross-feed adjusting hand-wheel at the front of the machine. Hand-wheel G at the side of the slide is mounted on a short pinion shaft engaging a stationary rack on the stand. This may now be operated to give a rapid movement to the slide. Rocking cam F downward again by the lever at the front of the machine again throws clutch C into engagement and gives a fine cross adjustment from the regular hand-wheel.

The rapid movement thus provided is useful for moving the wheel slide quickly from one extreme of its travel to the other, so as to thoroughly distribute the oil along the ways of the wheel slide. This is very important, particularly in starting the machine after it has been idle over night, or for some time during working hours. If these bearings are not thoroughly lubricated it is impossible to get the fine adjustments required, which often have to be made as close as 0.000125 inch. This quick movement is also useful in altering the adjustment of the wheel for considerable changes in the diameter of the work.

Another point of interest shown in Fig. 3 is the method of gibbing the wheel slide to the stand. Gib H is fitted into position by scraping, and is drawn down tightly into place by means of the bolts shown. This construction does not permit the operator to tamper with the adjustment. If it becomes necessary after years of service to compensate for the wear at this point, this is done by removing the gib and scraping its upper surface until the desired closeness of fitting is obtained.

The spindle construction is shown quite plainly in Fig. 3. The spindle is of one diameter throughout the main part of its length, and is exceptionally heavy. Suitable oil wells with felt distributing pads are provided, and the boxes are self-aligning and adjustable for wear. The thrust of the spindle is taken by two washers, bearing in spherical seats in the hub of stationary sleeve J. This construction makes possible a much closer fit, so far as end movement is concerned, than can be obtained in any other way. A two-step cone pulley is provided to keep up the speed as the wheel wears down. A safety belt stop shown at K attached to the adjustable cap of the wheel guard, makes it impossible to shift the belt on to the smaller step until the wheel has worn down to a point that makes it safe to do so.

The automatic cross-feed is of the standard design developed by the makers. The simple pressing of a thumb latch sets the feed for any desired size, automatically stopping it when the required depth of cut has been reached. The feed can be set to give the full amount at either or both ends of the stroke. The same movement also, if desired, may be used for giving a fine hand feed. The hand-wheel is graduated to read to thousandths of an inch on the diameter of the work.

Improvements in the Table Traverse Mechanism

Figs. 4 and 5 show quite plainly the mechanism of the automatic traverse for the table. The reversing device is of the "load and fire type," which has been used for many years by the builders. Arm K in Fig. 4 is keyed to a rock-shaft extending through to the front of the machine, where it is actuated by the adjustable reversing dogs at the front of the
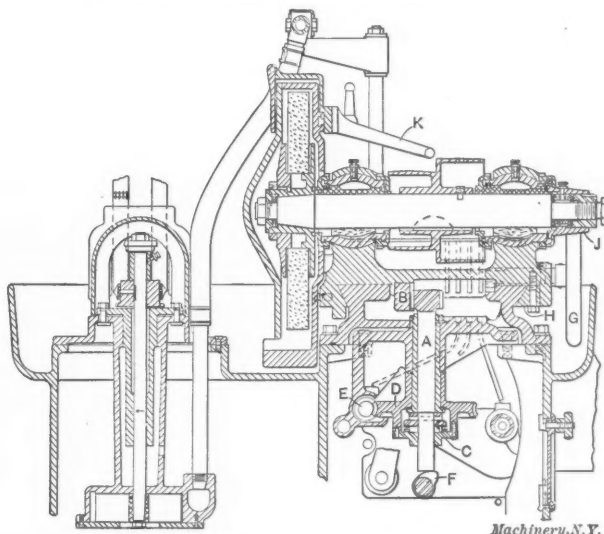
Machinery,N.Y.

Fig. 3. Cross-section through Grinding Head Spindle, showing Centrifugal Pump and Improvements in Cross Feed

carriage. As the carriage approaches the end of its movement, arm K is rocked to the right or left as the case may be. If rocked to the left in Fig. 4, by means of the connecting rod and tappet L, spring M_1 on rod N is compressed, bringing block O_1 against the catch on latch P_1. Continued movement of L to the left finally raises latch P_1, allowing O_1 and N to fly to the left under the impulse of compressed spring M_1. Latch P_2 then drops in behind block O_2. The movement of N to the left, by means of fork Q, throws feed-shaft R to the left, and with it the reversing clutch S, which is keyed to it. The table traverse is thus reversed. At the end of the stroke

in the other direction, L is moved to the right, spring M_2 is compressed, latch P_2 and N, Q, R, and S are thrown to the right, thus again reversing the table. This mechanism avoids the possibility of stopping the clutch on dead center.

An improvement in the design makes it possible for the operator to stop the traverse at the end of the stroke if he desires. This is clearly shown in Fig. 5, where the same reference letters apply as in Fig. 4. A knob T in the center of the traverse movement hand-wheel X, by means of the connections shown passing through the hollow shaft, operates the plunger U. By pressing the knob T, U may be held under spring pressure against the surface of revolving clutch S. When the latter, at the end of the stroke, flies over under the influence of springs M_1 and M_2, latch U drops into the groove
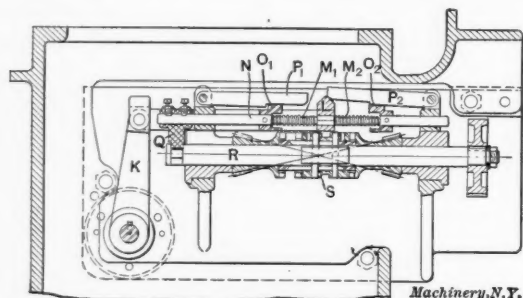
Fig. 4. The "Load and Fire" Reverse Mechanism for the Table Feed

turned in the periphery of S, holding it in the central position. The workman may thus at any point of the stroke of the machine set knob T to stop the traverse at the end of the stroke. This requires less watchfulness and care, and leaves the operator free to concentrate his mind on the matter of making accurate measurements. The spring detent at V holds the knob T in either its open or closed position. The withdrawal of the knob again starts the traverse without requiring any further movement on the part of the operator.

Knob T serves another purpose simultaneously with that of stopping the machine at the end of the stroke. It is pinned to the shaft which receives the movement from the feed gearing, and is provided with clutch teeth engaging corresponding teeth on the hub of hand-wheel X. The latter thus hangs free during the operation, and is only thrown into engagement with the table traverse gearing when the operator stops the power movement. This is advantageous in the production of accurate work. The nature of the grinding operation requires the operator to stand close to the machine for the delicate adjustment of rests, etc., during the movement of the table. This is inconvenient and dangerous with a revolving hand-wheel having a handle protruding from it. Besides this, the hand-wheel is necessarily geared up to give an easy and accurate movement to the table when facing a shoulder on a piece of work. This means a comparatively high speed, so that its momentum becomes a serious factor in reversing the direction of the table feed mechanism. Since with this improved arrangement the hand-wheel never reverses, it can be made much larger in diameter than has hitherto been possible. Throwing it into engagement, as explained, requires no further movement on the part of the operator than that of stopping the machine.

Another improvement in the table feed mechanism is effected by the gearing shown at Z, in Fig. 5. This gives two rates of table feed, controlled by a hand lever (shown just above the table hand-wheel in Fig. 1), mounted on shaft B. When this lever is set for the slow movement and the belts on the counter-shaft cones are properly set for roughing out a piece of work, the shifting of the feed gearing to the fast movement makes the proper change in the table feed for the fine finishing cuts desired for bringing the work down to size. It is thus possible to have the proper feeds for roughing and finishing without requiring the shifting of belts during the progress of the work.

Improvements in the Driving Mechanism

The counter-shaft of this machine has been re-designed so as to make the wheel and work speeds and the table feeds entirely independent of each other, so that either of the three may be changed without affecting the others. This feature,

particularly in relation to the work speeds and table feeds, is an important factor in commercial grinding. By this arrangement it is possible to obtain a correct table feed for any work speed, so that when it is desired to remove stock rapidly, a slow speed and fast feed are available. Any of the changes can be made without stopping the wheel, work or table.

A further convenience in the drive is afforded by the horizontal lever shown at the left of the bed in Fig. 1. This is for starting and stopping that portion of the overhead works that feeds the table back and forth and reverses the work. This lever replaces the shipper arm generally employed for this movement, and changes the tiresome horizontal movement over the workman's head to a vertical movement in a convenient position where his hands would naturally be in operating the machine. As this lever is moved every time a piece of work is calipered or removed from the grinder, the relief to the operator becomes an important factor in increasing the output of the machine. The connection with the counter-shaft is by means of a piece of wrought iron piping not shown in the engraving. This improvement has been found of so much importance that all of the grinding machines in the shops of the builders have been equipped with it even when it was not provided for in the original design.

General Dimensions and Specifications

The machine takes work 8 inches in diameter and 36 inches long. It takes a wheel 16 inches in diameter, 1 inch or 1½ inch face. The automatic cross-feed ranges from 0.00025 to 0.004 inch at each reversal of the table. The scale for the swivel table reads up to 8 inches per foot and 3½ degrees
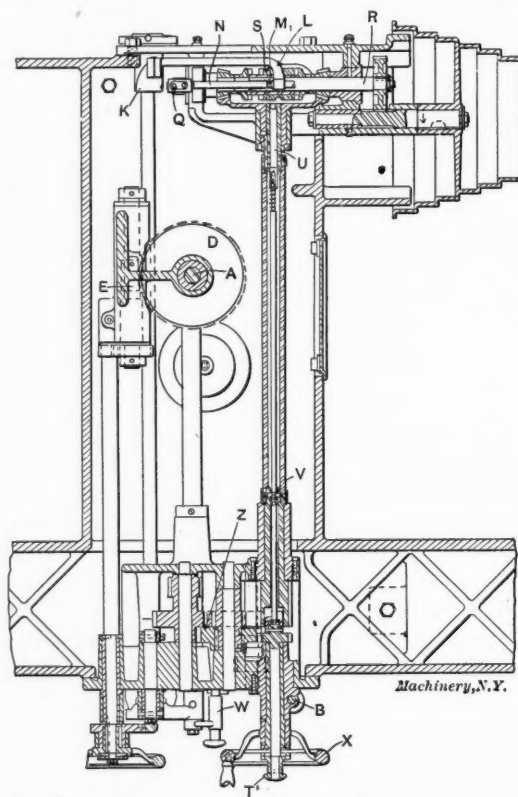

Fig. 5. Horizontal Section of the Feed and Traverse Mechanisms

taper. The ways of the table are provided with roller oil distributors, and are protected by metal covers. The table movement is controlled by quick shifting dogs with micrometer adjustment. Six changes of wheel speed are provided, ranging from 1,200 to 2,400 revolutions per minute. There are twelve changes of work speed, from 42 to 312 revolutions per minute, and twelve changes of table feed, from 8 to 100 inches per minute in two series, available for any work speed. The counter-shaft is driven by tight and loose pulleys 14 inches in diameter for 4-inch belt, and should run about 400 revolutions per minute. The floor space occupied is 144 inches by 51 inches. The net weight of the machine is 5,050 pounds. The equipment includes one plain back-rest, four universal back-rests, a center rest, center grinding attachment, water guards and a set of dogs. Two grinding wheels are also provided, together with wrenches and complete overhead works.

FOOTE BROS. SPUR GEAR SPEED REDUCER

The Foote Bros. Gear and Machine Co., 44-50 No. Carpenter Street., Chicago, Ill., have devised a very neat form of speed reducing gearing, intended particularly for direct connection to electric motors. As may be seen from the engraving, the casing of the mechanism in itself closely resembles a motor, so that the combination of the two on the same base plate gives a pleasing mechanical appearance to the apparatus. In laying out the design it has been the endeavor to get the reduction for the horse-power required as nearly as possible into the same center height as the motor, thus avoiding raising strips on either the reduction or the motor.
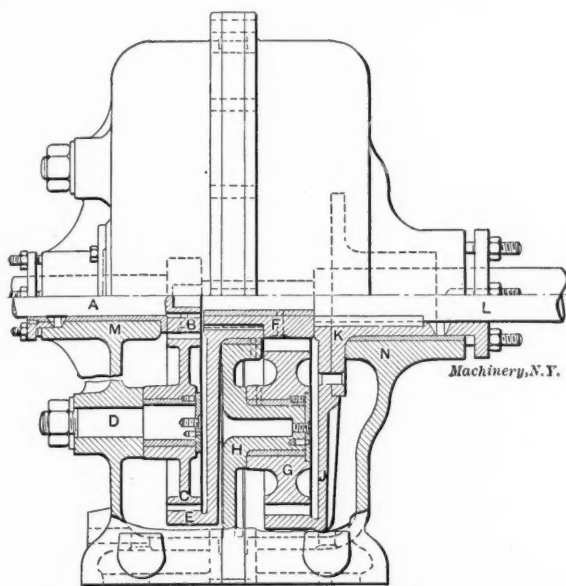
An Enclosed Spur Gear Reduction Mechanism of Rigid and Pleasing Design

This reducer employs spur gears only, the two larger members being of the internal spur gear type. The driving shaft at A has keyed to it a steel pinion B, meshing with a series of four intermediate gears C, of which one only is shown. This intermediate runs on a stud D, fast in the casing head M. It meshes at its outer diameter with the first internal gear E, which is journaled in a bearing in diaphragm H. The hub of E is keyed to pinion F and the latter is bored and bushed as shown, to furnish a bearing for driven shaft L, so that L, F and E support and stiffen each other. Pinion F engages with a second series of intermediate gears, of which one is shown at G. These are journaled on bearing studs integral with the diaphragm H. Pinions G mesh with the second internal gear J, riveted to flange K, which is in turn keyed to the driven shaft L.

It will be seen from the engraving that the design provides for a mechanism of high class, especially as relates to rigidity and durability. All the bearings throughout the casing are bushed with phosphor bronze, and are of ample length and diameter. The studs for the idlers are rigidly supported, so that there is no chance for springing or loosening to cause cramping of the teeth, with consequent breakage. It will be noticed also that the driven or slow speed shaft is supported at the center of the diaphragm, as well as at the outer bearing. The internal gears, which are the only ones rotating in the oil, have long hubs, preventing them also from tipping sideways and cramping the teeth. These internal gears distribute the oil effectively over the whole driving mechanism. The shafts are provided with glands, as shown, packed to prevent leakage of the oil. Since the high speed shaft does not pass through the slow speed internal gear, it is not necessary to turn this shaft down. Stopping off the high speed shaft in this way allows the use of a more compact design to transmit the power the device is intended for.

In comparison with other spur gear reducing mechanisms, the makers call particular attention to the following points: Strong central support of the shafts, and particularly of the idler studs in the diaphragm; smooth frictionless action of the parts in the oil bath, instead of the thrashing and consequent loss of power resulting from the rotating of idler plates or disks at high speeds; no rotating parts so constructed as to be liable to get out of balance, so that the machine runs smoothly and is not racked to pieces. These speed reducers are made in three styles, one of them with a compound idler for extreme reductions. The ratio of reduction may be made anything desired from 8 to 1, to 60 to 1. For ratios greater than 60 to 1, the makers prefer to furnish a worm gear spiral reduction as being better adapted to the conditions. These reducers are made in seven sizes, ranging from 1 to 50 horse-power capacity. They will be furnished, if desired, with a universal coupling between the motor and the casing, to obviate all danger due to misalignment of the armature and driving shafts.
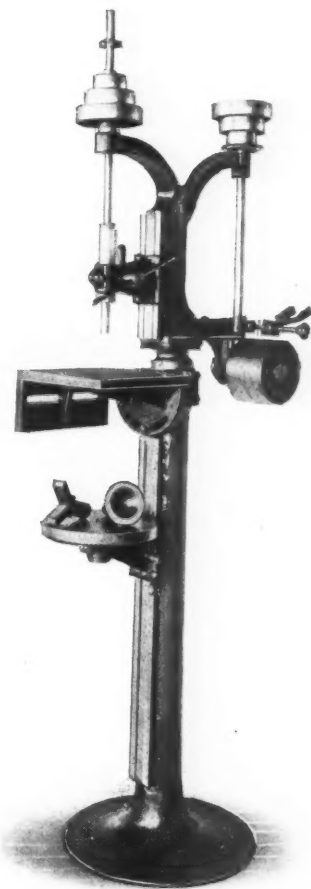
REED 13-INCH SINGLE SPINDLE DRILL PRESS

The new single spindle drill press illustrated herewith is built by the Francis Reed Co., Worcester, Mass. It is noteworthy from the number of adjustments provided. It embodies a sliding head and sliding table, with provision for either tilting or swinging the working surface of the latter. The drive also is unusual in being set parallel with the machine, so that the latter faces the line-shaft, thus agreeing also with the makers' regular A style of drill press.

Straight belts only are used, all quarter turns and twists being done away with. The parallel drive is accomplished through miter gears, one of which is rawhide, connecting the counter-shaft with the vertical driving shaft. The latter runs on a step to prevent the gears from crowding together. The counter-shaft, which is a part of the machine, runs in a bushing on an extension of the frame. The loose pulley runs on a hub on the outside of the frame, and has no connection with the shaft, so that conditions are ideal so far as durability and lubrication are concerned. The changes of speed are obtained by three-step cones at the top of the machine. The main drive is down low enough to reduce the vibration to a minimum, so that with smooth belts no shaking is noticed at the highest speeds.

The table is large and

The Reed 13-inch Drill Press

heavy, having a 12 by 12 inch surface with an angle plate 12 by 6 inches. This latter may be used to take a chuck for centering long work, making it unnecessary to throw the whole table around at right angles. The style of table shown tilts 45 degrees on each side of the center, the angle plate taking care of the other 90 degrees. Three styles of table will be furnished; the plain round table, a tilting and swinging table, or a plain swinging table. Cup and V centers are furnished with each machine to fit the lower arm. They are aligned with the spindle so as to center the drill properly.

The machine is furnished with either a No. 1 or a No. 2 Morse taper spindle. The spindle has a feed of 5 inches, and the vertical head is adjustable for 12 inches. The lower table has a vertical adjustment of 32¼ inches. The total height of the machine is 70 inches and the weight is about 280 pounds. The machine has a capacity for drills up to ½ inch, and is capable of extremely high speed.
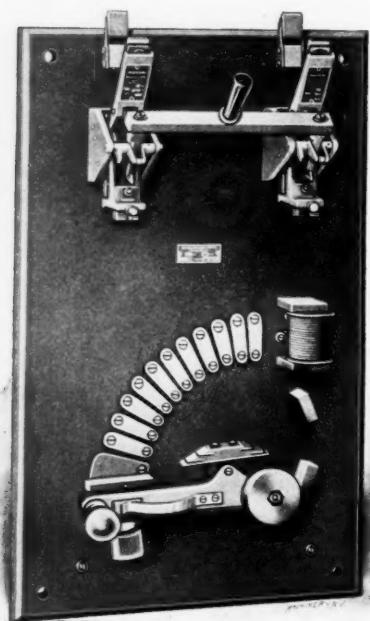
WESTINGHOUSE STARTING PANELS FOR DIRECT-CURRENT MOTORS

The illustration shows one of a line of starting panels recently placed on the market by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. This panel has been found better than the usual separate starting boxes for many installations, since it insures a more satisfactory location for the rheostat, switches and fuses or circuit breaker than when these parts are mounted separately. Each panel consists of a slate slab, on which the parts are mounted. In the smaller sizes the resistance is mounted on the back. The terminals are so plainly marked that there is little excuse for anyone making mistakes in the wiring, even though unfamiliar with apparatus of this kind.

The engraving shows what is known as the type "ZB" starting panel, on a carbon break circuit breaker. Other styles are provided with fuses in place of the circuit breakers. All of them have a low voltage release coil, independent of the field circuit so that any panel may be used for shunt, series, or compound motors. All the contacts are protected from burning by a quick arcing tip on the front of the panel, or by a blow-out coil on the rear, which also prevents burning the contact on opening the circuit.

Westinghouse Starting Panel, equipped with Circuit Breaker

As stated, these panels are furnished with either fuses or circuit breakers. Both have their advantages. The fuse will carry currents in excess of its capacity for brief intervals, so that it may perhaps be considered preferable for motors that are liable to very brief over-loads, and have expert supervision. The circuit breaker opens immediately, as soon as the circuit reaches the strength for which it is set. It can be reset in less time and less trouble than is required to replace burned-out fuses. Either the circuit breaker or the fuse opens the circuit of the low voltage release magnet, so that the motor is protected from over-loads at all times.

This line of starting panels is furnished in a wide range of sizes, for motors from ¼ horse-power at 110 volts, up to 120 horse-power at 220 volts. A wide range of panels for 500-volt circuits is included in the list. They are made in several different styles, either for mounting on wall brackets, or provided with tubular supports resting on the floor.

LEEDS & NORTHRUP HARDENING AND ANNEALING PYROMETER

In the department of New Machinery and Tools of the March, 1909, issue of MACHINERY, we published a short note describing a pyrometer placed on the market by the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. The distinctive feature of this pyrometer was its use of a pure platinum conductor exposed to the heat to be measured, in place of the usual thermo-electric couple. The resistance of this conductor was measured by an instrument of the same type as an ordinary ammeter. This arrangement combines the convenience of a pyrometer of the ordinary type with the easy reading and durability of the standard electrical measuring instruments. The current used is obtained from any direct current system, and the readings are practically independent of voltage fluctuations.

In the apparatus previously described, the operation of measuring consists in adjusting a resistance for about the de-

sired temperature (within 200 degrees) and then reading the finer calibrations on the ammeter dial. The improvement consists in furnishing a form of direct reading resistance or "indicator," as it is called, which may be set exactly to the temperature desired. Then the pointer of the deflector or ammeter will stand at 0 when the furnace has been brought to this temperature. There are 100 divisions on either side of this 0 point. When the temperature is 50 degrees too high, the needle stands approximately on the + 50 mark; when it is 75 degrees too low, the needle stands approximately at —75, etc. By turning the index on the indicator, the temperature corresponding to 0 may be varied at will. Thus, if it was desired to treat a piece of steel at 1,380 degrees F., the index would be set at 1,380, and the temperature of the furnace raised until the needle stood at the center of the scale. If the next piece was to be heated at 1,420 degrees F., the index would be set at 1,420, and the needle again brought to the center of the scale.

The apparatus is shown diagrammatically in Fig. 2. A and H represent the terminal poles of the apparatus where it is connected to the shop lighting or power circuit, storage battery or other convenient source of current. From A the circuit leads to the shifting contact C of the indicator. From C the circuit flows through the resistance on either side, flowing out through E to D or through F to D'. D and D' are two coils of a balanced ampere meter, forming the deflector. When the current is the same in each coil, the dial indicates zero. When the current is stronger in one coil than the other, this condition is shown on the dial by a deflection to the right or left, as the case may be. The upper circuit of
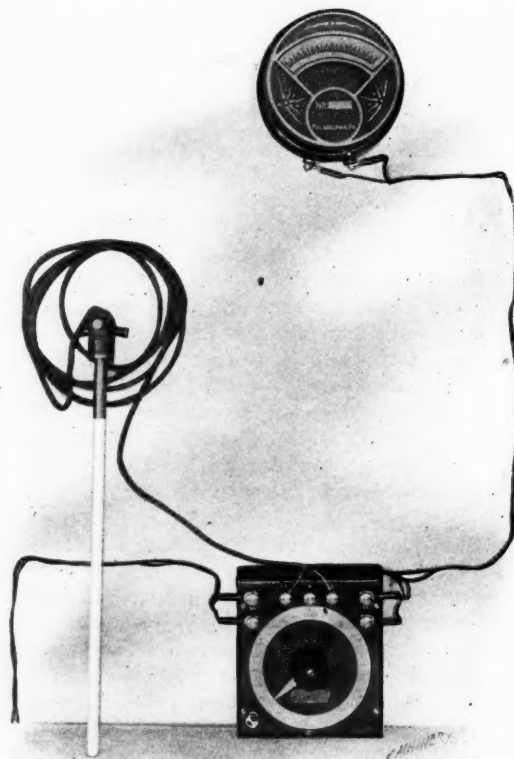

Fig. 1. A Pyrometer used on an Ordinary Lighting Circuit, which gives Magnified Readings for Minute Temperature Changes

the divided current passes from D' through the bulb B, containing the platinum resistance member, which is subjected to the heat, and back to the minus binding post at H. The other half of the divided circuit leads from coil D of the ampere meter through the permanent resistance G, back to the binding post H.

The action of the apparatus will now be easily understood. The sliding contact C is set to indicate a desired temperature. When so set, as shown in Fig. 2, the resistance of the upper circuit is decreased while that of the lower is increased. (It should be mentioned that the permanent resistance G has the same resistance as the bulb B at normal temperatures, and it is made of a material whose conductivity

is unchanging for changes of temperature, so that no attention has to be given to the cold end of the apparatus.) Owing to the smaller resistance in the upper circuit, the needle of the balanced ampere meter will fly to one side indicating this condition. If now the element be subjected to heat, its resistance will be gradually increased until both branches of the circuit are again carrying the same amount of current, and the indicator dial, under the influence of coils D and D' again indicate a balanced condition. If contact arm C is again moved upward, so as to further increase the resistance of the lower circuit, the element B has to be heated to a still higher temperature to bring the ampere meter to balance again. It will thus be seen that each position of the contact arm C corresponds, when the ampere meter is in balance, to a definite temperature of B, no matter what the voltage of the current flowing in the apparatus. By indexing these definite temperatures with graduations on the resistance box, a very effective means of temperature control is provided.

The ordinary thermal couple instrument has crowded on its single 6-inch scale its total temperature range from 0 to 2,000 degrees F. In a given process with a given kind of iron or steel, at least 90 per cent of this scale is never used. On such an instrument, ⅛ inch on the scale corresponds to from 20 degrees to 50 degrees. On this deflection indicator, ⅛ inch corresponds to 5 degrees approximately. The workman does not have to remember at what temperature he is working. The deflector does not tell him what the temperature of the furnace is; it tells him that the furnace is so many degrees from the correct temperature. He can at any time, by looking at the index on the box, tell at what temperature the furnace is supposed to be held. Or, should it be desired, this index may be in the superintendent's office or kept from the furnaceman's sight. In any case, the first thing that strikes the furnaceman's eye is that the temperature is higher or lower than it should be, or that it is just right, depending on whether the
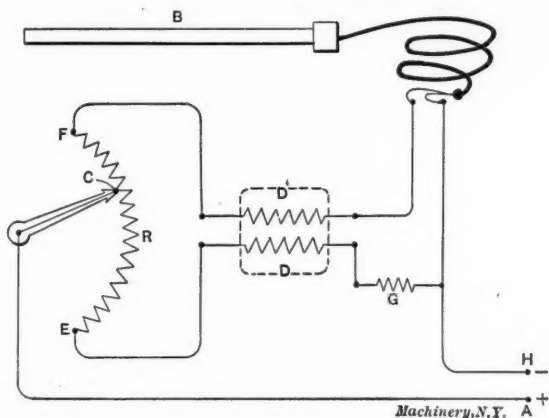
Fig. 2. Diagram illustrating Principle of Action of Leeds & Northrup Pyrometer

needle is to the right or the left of the center or just in the center. When 30 degrees means a deflection half way off the scale of the pyrometer, even the most careless workman will get busy to correct the error, but when 30 degrees means only 1/16 inch to 1/8 inch motion, the average man naturally thinks "that little bit won't hurt."

It does not require a deep knowledge of psychology to know that small things do not receive the consideration that big things do. With the average workman reading a pyrometer, it is the amount of space covered by the needle which counts; the scale receives scant consideration. An eighth of an inch is to him an eighth of an inch, regardless of whether that eighth of an inch stands for 5 degrees or 50 degrees. Hence a pyrometer on whose scale an eighth of an inch equals 5 degrees acts on the workman as an unconscious stimulant to accuracy.

It is also true that with a pyrometer readable to 2 degrees it is very much easier to control temperature within set limits than it is with an instrument readable to only 25 degrees, for the reason that as soon as the source of heat, be it gas, coal, oil or electricity, begins to vary, the change is immediately noticeable and may be immediately remedied. This does not give the furnace conditions a chance to get "a set" which necessitates radical action to correct, such action starting the temperature change too far in the other direction.

From what has been said it will be seen that this instrument is primarily designed for telling the operator whether or not his furnace is being maintained at the proper temperature; what this particular temperature is, is really to the workman a matter of secondary consideration. In fact, it is occasionally desirable that he should be kept in ignorance of it. The usual construction of pyrometers emphasizes first of all the true temperature, often in unfamiliar units, and the workman must transpose this in one way or another to figure out how far his temperature is in error. The measurement of temperatures is in reality a problem in electrical measurement. The makers' long experience and high reputation in this work gives them confidence in introducing this new form of pyrometer for general use.

LANG TOOL-HOLDER FOR TRIANGULAR BLADES

The tool-holder illustrated herewith is made by the G. R. Lang Co., Meadville, Pa. The makers believe that they have
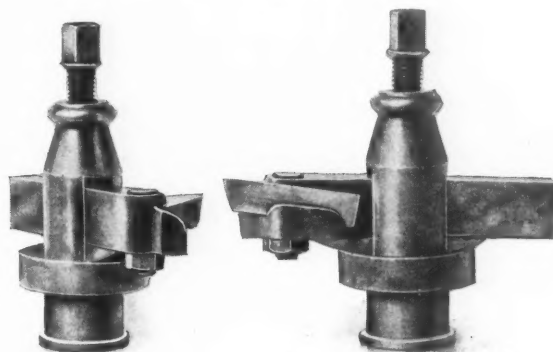

Fig. 1. A Simple and Rigid Tool-holder, using a Blade of Triangular Section

succeeded in producing an inserted blade tool-holder which will effectively take the place of the solid forged tool in general work. The blade, as may be seen, is made from triangular steel, which is rolled in bar length accurate to size. The shape of the stock and the provision for clamping allows the use of a cutter of much larger section than is possible in the old style tool-holder.

The seat for the blade and the way in which the point is ground gives it an angle of nine degrees back rake at the top, and fifteen degrees side rake. The clearance angles on the front and side are ground to about seven degrees, with very little waste of steel. To secure the same conditions with a cutting edge of square section would require stock about twice the area, and would necessitate the grinding away of a considerable amount of high-speed steel.

As an example of the heavy blades used, it may be stated that in the ⅝ × 1¼-inch tool-holder, a ¾ triangular steel bar is used, as compared with the usual ⅜-inch square. The cutter is supported entirely on the end opposite the direction of the thrust of the cut, and is held by a method which in-

Fig. 2. The Holder with Blade Removed, showing Method of Holding

sures rigidity. There is no swell or head on the side to interfere with working close up to a shoulder, and there is no obstacle on the top to the passage of the chips. This makes it unnecessary to furnish offset tools. Severe tests have shown that the blades will not slip under the heaviest cuts. It is made in both right and left-hand styles and may be used as a side tool or as a drill starting tool, as well as for ordinary turning.
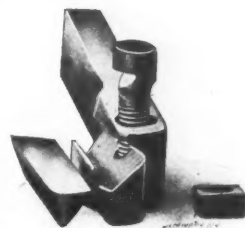
GRATON & KNIGHT CO.'S SPARTAN BELTING

The Graton & Knight Mfg. Co., of Worcester, Mass., has recently placed on the market a new brand of belting which they call the "Spartan." The special advantage claimed for it is pliability. This carries with it the advantage of dur-

ability, and closer gripping of the belt at less tension. The belting is also claimed to be steam-proof, and to be unharmed with contact of lubricating oil. It is proof, also, against the action of hot water, coal gas, and acid fumes, so that it would seem to be able to stand almost anything it is likely to come in contact with. The makers give the strong guarantee that "it will, when used under the same conditions, outlast any other belting material."

WESTERN GEARED DRIVE PLAIN RADIAL DRILL

The radial drill herewith illustrated and described, is built by the Western Machine Tool Works, Holland, Mich. It is notable from the ingenious design of the geared driving mechanism, the thorough provision for automatic lubrication of
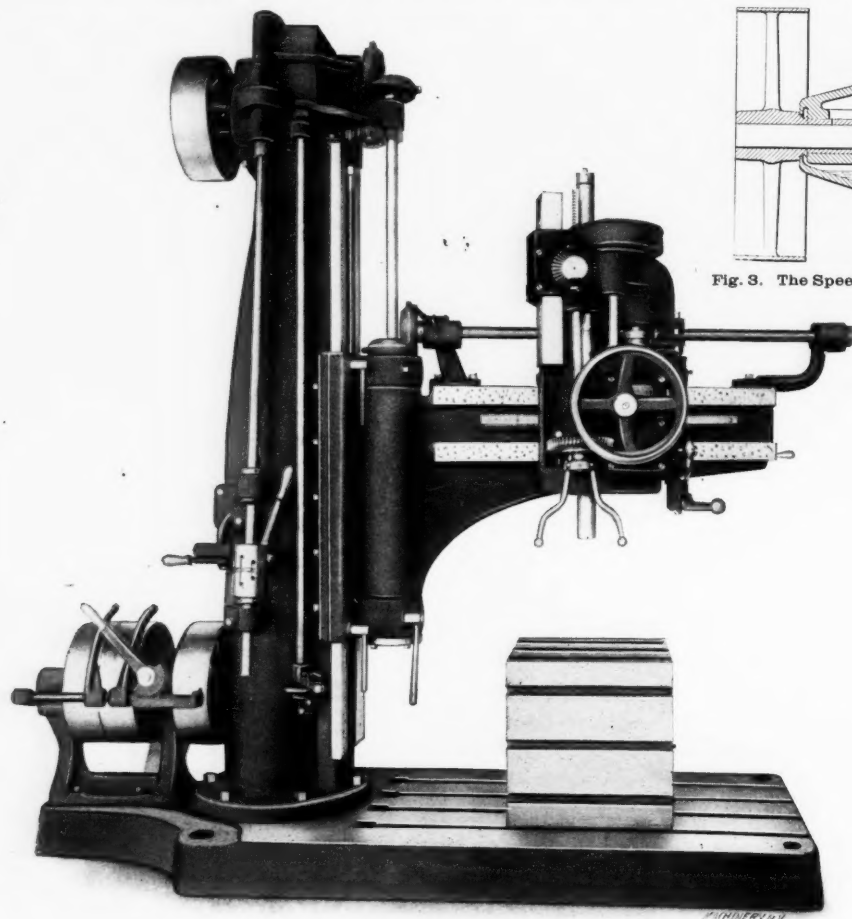
Fig. 1. The Western Plain Radial Drill, with Geared Speed Changes and Positive Feeds

all important members, and the wide range of feeds and speeds provided. Another noticeable feature is the maker's well-known method of driving the spindle from a gear at the lower end, as shown in Fig. 8.

The Driving Connections

As may be seen in the front elevation, Fig. 1, the usual vertical shaft passing up through the column is dispensed with, a belted connection being made instead between the counter-shaft at the base of the column and the change gear box at the top. The counter-shaft has self-oiling journals and a self-oiling loose pulley. The individual oil reservoirs contain enough oil to last for a year of constant use. The loose pulley is of single piece construction with a reservoir cored around the bearing, packed with cotton and oil. In the reservoirs of the journals and the loose pulley, wicks are provided, leading from the bearing surface to the oil supply. A feature
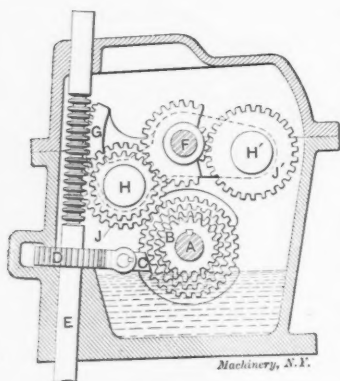
Fig. 2. End View of Change Gearing, showing Control by Rod E

of the counter-shaft, which will be seen in Fig. 1, is the belt shifter. This, by means of the rack and sector construction shown, gives such a leverage that the shifting of the belt requires but a very light touch of the hand. If a motor drive is desired on the machine, a constant speed motor may be bolted on in place of the counter-shaft with very little trouble, being belted to the gear box at the top of the column in the same way.

Figs. 2 and 3 show the construction of the speed change box. The constant speed shaft A is keyed to the pulley which,
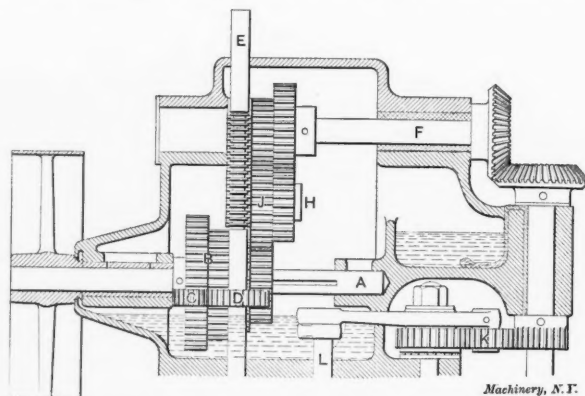

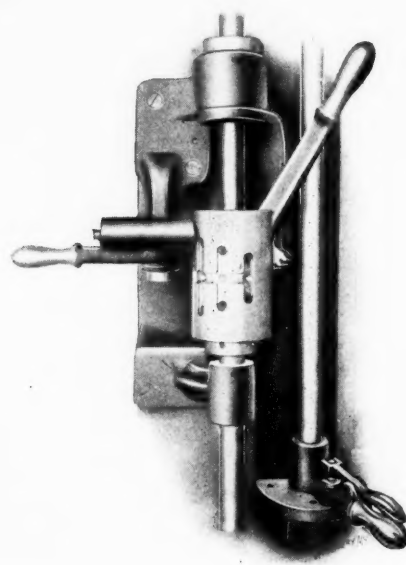Fig. 3. The Speed Box, furnishing Eight Changes on the Selective Principle

Fig. 4. Speed Changing Control at Lower End of Rod E

in turn, is belted to the counter-shaft or driving motor. A cone of 4 gears B is splined to shaft A and may be shifted thereon longitudinally, by means of fork C, sliding on the stud fixed in the gear casing. The rear side of the fork has rack teeth cut in its face, engaging a gear D, keyed to the vertical shaft E so that the rotating of the latter shifts the cone of gears B. The shaft to which the variable speed is transmitted is shown at F. This has mounted on it a rocker arm G, having two pivots H and H' supporting two intermediate gears J and J'. The latter is directly geared to pinion shaft F, while J is connected by compound gearing as shown. In the upper part of rod E are cut circular rack teeth, which engage corresponding gear teeth cut in the sector face of rocker arm G. Rod E may be both raised and lowered, and rotated to the right and left. Raising and lowering it rocks arm G and permits either J or J' to mesh with the corresponding gear on shaft A, as may be required. Rotating to the right or left shifts the cone B on shaft A, to bring either one of the four gears into position to engage either J or J'.

As may be seen in Fig. 4, a drum is mounted on the lower end of E, which is guided and locked in position by a lock bolt and lever shown. Raising or lowering this drum by means of the handle provided, brings J or J' into mesh with the mating gear B. Rotating the drum and shaft E brings either

one of the four gears on A into position to mesh with J or J'. By this means eight changes of speed are provided by a

This is operated by a handle attached to the vertical rock shaft L, plainly shown in Fig. 4. The arm rests and turns
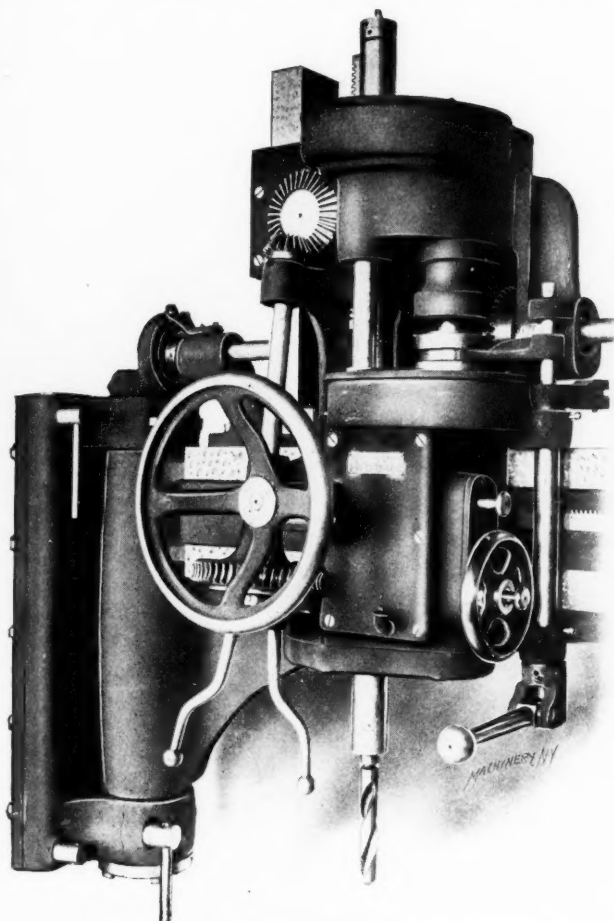

Fig. 5. The Spindle Head, showing Enclosed Construction

very simple mechanism, with no possibility of interferences or false moves. An inspection of Figs. 2 and 3 shows that at
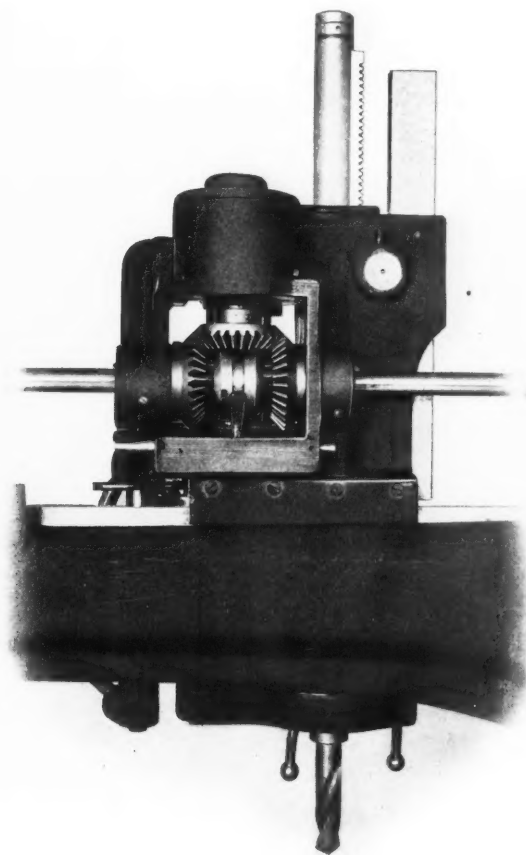

Fig. 6. Rear View of the Head, showing Tapping Reverse for Spindle Drive

on ball bearings in the slide, giving the operator an easy and quick adjustment.
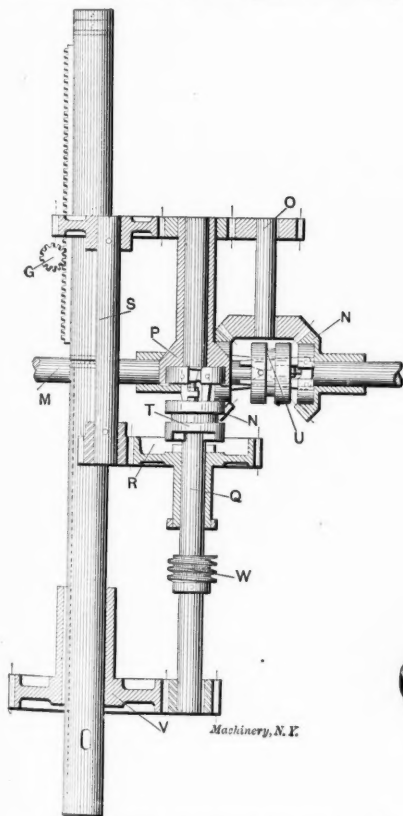
The Driving Mechanism in the Head

From the speed box the power is transmitted through two sets of bevel gears to the horizontal shaft on the arm. Figs. 5 and 6 show front and rear views of the head respectively, while Figs. 7 and 10 show the details of the driving mechanism. M is the horizontal driving shaft. It has revolving loosely upon it bevel gears N and N. Either of these may be connected to M at will by means of the friction clutch shown in Fig. 9, so that short shaft O may be driven either forward or backward. The latter is geared with a loose quill P on spindle driving shaft Q. A second loose quill gear R, also mounted on Q, receives the movement from P through the back gear shaft S. Q may be clutched to either R or P, as may be required, by shifting clutch collar T. When this is dropped, Q is clutched positively to R. When it is raised, it is engaged

Fig. 9. The Friction Clutch for Connecting the Power Feed

with P by means of the friction clutch shown. This back geared drive, in connection with the speed box, gives sixteen changes of spindle speed, suitable for driving anything from a ⅜-inch drill to a 6-inch pipe tap.

The matter of lubrication of these members, seen most plainly in Fig. 10, should be noted. The driving gears are all enclosed in oil-tight casings, and are provided with reservoirs of oil for both the bearings and the gear teeth.

It should be noted that the same handle is used for the reversing clutch and the back gear clutch. This is shown at
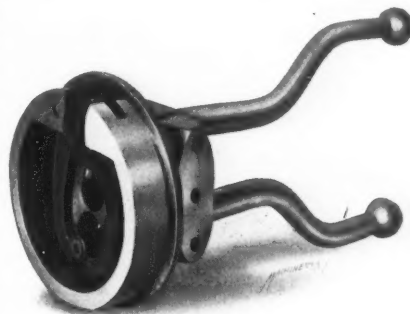

Fig. 7. Diagram of Driving Gearing in Head

Fig. 8. The Spindle with Large Diameter Driving Gear, close to the Drill

this point also the matter of lubrication has been carefully considered.

The vertical screw for raising and lowering the arm is driven through the tumbler gearing shown at K in Fig. 2.

the lower right-hand side of the head in Fig. 5. Raising and lowering this handle operates clutch T and controls the back gears. Swinging it to one side or the other operates clutch U for reversing the spindle movement. The starting, stopping, back gears and tapping device being thus controlled by one handle, it is possible to throw from one position to the other instantly, without danger of conflict or interferences.

The head is rigidly constructed, with webs of suitable thickness. The stiffness of the spindle drive is enhanced by the position of the driving gear V which is splined to the lower end of the spindle where it is driven by a pinion on shaft Q. The spindle and the driving gear are shown separately in Fig. 8. The spindle is thus driven in its large diameter and close to the gear, minimizing the torsional deflection, which is localized in a short, stiff length of spindle. In the ordinary construction, the power has to be transmitted through a long, slender spindle, cut down to pass through the feeding quill. It is stated that a torsional rigidity is obtained of from $2\frac{1}{2}$ to 3 times that given by the usual construction. This drive is, we believe, an exclusive feature of the Western machine.

The Feed Gearing

The feed mechanism is shown plainly in Fig. 10. The spiral gear W on shaft Q (Fig. 7) engages a mating gear X in the feed box. The shaft on which X is mounted carries also two gears, either of which may be connected with it by sliding the pull pin Y in or out, thus giving two rates of speed to the cone of gears Z. Gears Z in turn mesh with corresponding gears A, any one of which may be keyed to shaft B by means of the pull pin C. Eight feed changes are thus obtained, ranging from 0.008 to 0.060 inch per revolution of the spindle. These gears are enclosed in an oil-tight casing and run in oil.
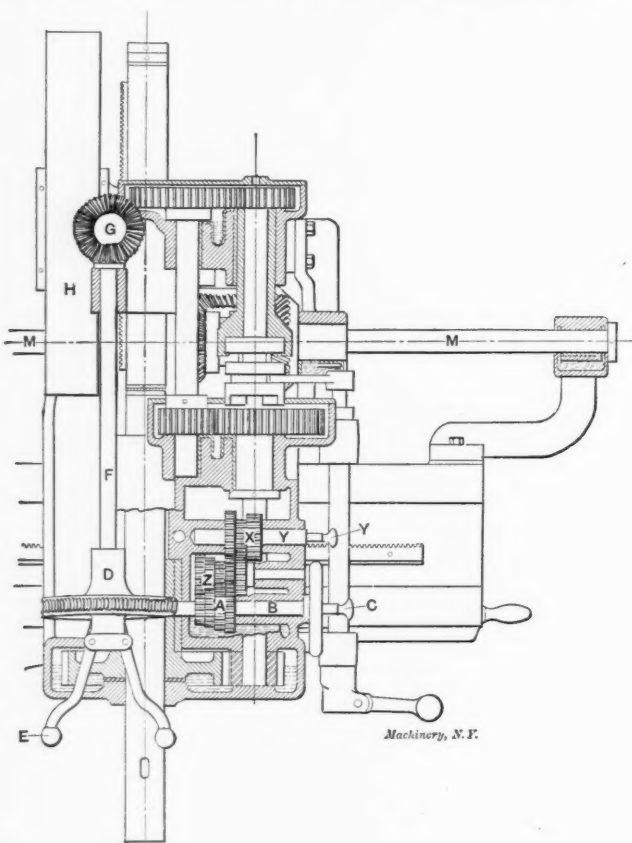

Fig. 10. The Positive Quick Change Feed

A worm on shaft B engages worm wheel D. This is clutched to the feed shaft by the mechanism shown in Fig. 9, operated by handles E (see Fig. 10). These serve to operate the clutch or to feed the spindle rapidly by hand when the clutch is disengaged. By pressing together handles E, a toggle joint mechanism expands the friction ring of the clutch, thus giving a powerful grip with easy operation. A suitable wedge is placed between the two fingers to vary the gripping pressure as desired. This clutch is keyed to the vertical feed rod F, which transmits the movement through a set of bevel gears to the pinion spindle G. This latter meshes on one side with

the feed rack on the spindle quill, and on the other with the counter weight H.

The Western radial drill is built in four sizes having 3, 4, 5 and 6-foot arms respectively. As may be inferred from the illustrations and description here given, it is a strongly driven machine adapted to heavy work, and especially suitable for pipe tapping. Hill, Clarke & Co., of Boston, Chicago, and branch offices, are the selling agents.

FERRACUTE HAND SCREW PRESS

The tool illustrated herewith is a hand screw-press built by the Ferracute Machine Co., Bridgeton, N. J. It is designed for miscellaneous work of considerable area and height, hav-

A Hand Press, provided with Dial for Indicating the Pressure Produced

ing a bed 36 inches square and a maximum distance from the bed to the ram of 24 inches. It is designed for pressures of from 0 to 15 tons.

One of the features of novelty is the dial shown in the head of the press. The nut, set in the head, through which the screw runs, bears against a heavy steel spring, and the indicator hand on the dial is driven by a pin connected to this spring, giving the effect of a spring balance, which indicates on the dial the amount of pressure applied at any moment. Another point of interest is the combined hand-wheel and ratchet. Several tons pressure may be obtained by the hand-wheel alone. By connecting the ratchet lever, which may be done instantaneously, the maximum pressure is easily available. The ratchet is reversible, enabling the operator to start the ram upward with a minimum of effort.

The total height of the press with the screw raised is 98 inches. It occupies a floor space of 47 by 36 inches and weighs 2,300 pounds.

THE "STANTOOL" TAPER FOR DRILL SHANKS AND COLLETS

It seems to be practically agreed to that the old standard Morse taper shank and tang is too weak for the high duty required of it under modern conditions with modern cutting steels. The dimensions of the tang were settled on in days when the chips now taken with the twist drills would have seemed out of the range of the possible. To provide a stronger drive for new twist drills, and for giving added life to old ones from which the tangs have been broken, a number of devices and methods have recently been proposed. In the opinion of the Standard Tool Co., of Cleveland, O., all of these

devices have objectionable features. Some of them are complicated, some of them expensive, and some of them require a special preparation of the drill, which is only possible with the assistance of a skilled mechanic, and machines not found in every shop. This firm has therefore decided to meet the situation in a radical way. They are putting on the market drills having what they call the "Stantool" shank. While preserving the Morse taper, these shanks are shortened, thus permitting the use of a tang of much greater strength.
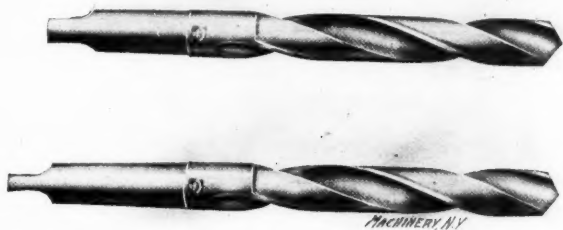
The New and the Old Standard Taper Shanks for Twist Drills

The upper drill in the engraving has the new shank, while the lower drill has the old standard. The difference in the strength of the tang will be seen at a glance. The dimensions are such that old drills on hand, whether broken or not, can be converted into the new type at very little cost and trouble. The makers furnish a gage which can be placed over the

Another disadvantage of the ordinary pin clutch is the necessity for a special brake for the crank-shaft. If this brake is not provided, the crank-shaft will not stop at its highest point after the fly-wheel has been released. The brake power acts constantly on the shaft, while the press is performing its work, and, therefore, a considerable amount of power is absorbed by the brake when the press is running continuously. Besides, the brake is rather unreliable, and requires frequent adjustment in order to do its work properly. Another disadvantage of many clutches is the loss of time. A number of clutches require that the fly-wheel at times make half a revolution before striking the clutch pin for engaging the crank-shaft.

In order to overcome the disadvantages referred to, Mr. M. Jaeger of 109 North Terrace Ave., Mt. Vernon, N. Y., has undertaken extensive experiments on a new design of automatic friction clutch, the results of these experiments being a device of the type shown in the accompanying illustrations. In Fig. 1 a clutch is shown as applied to power presses of smaller sizes. The main parts of this clutch are the eccentric B turned directly on the crank-shaft A, an expansion ring C, and a wedge D. The fly-wheel E is provided with a recess bored out in the hub in the side towards the press frame, and the whole clutch mechanism is placed in this recess. The eccentric in the design shown in Fig. 1 is turned directly on the crank-shaft, but it can, of course, be made as a loose ring and attached to the crank-shaft in any suitable manner. The fly-wheel revolves freely on the shaft, the hole in the fly-wheel being preferably lined with a bronze bushing.

DIMENSIONS OF "STANTOOL" SHANKS AND TAPER HOLES
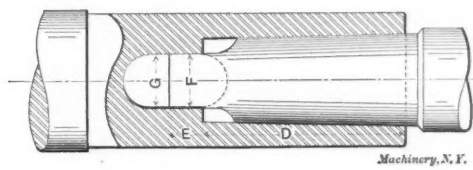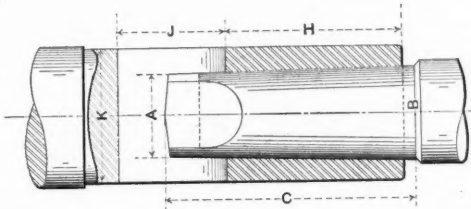
Number of Taper	Diameter, Small End of Shank	Diameter, Large End of Shank	Total Length of Shank	Depth of Hole in Socket	Length of Tongue to End of Socket Hole	Thickness of Tongue	Width of Keyway	End of Socket to Keyway	Length of Keyway	Diameter of Socket	Taper per Foot	Taper per Inch
	A	B	C	D	E	F	G	H	J	K		
1	0.378	0.484	2 1/16	1 1/4	1/4	1/4	0.263	1 5/8	3/4	35/64	0.600	.05000
2	0.587	0.706	2 5/8	1 5/16	1/16	1/4	0.388	1 3/4	1	1 1/16	0.602	.05016
3	0.800	0.941	2 13/16	2 1/4	9/16	5/16	0.520	2	1 1/4	1 5/16	0.602	.05016
4	1.050	1.244	3 1/2	3	1/16	5/16	0.645	2 11/16	1 1/2	1 11/16	0.623	.05191
5	1.515	1.757	4 5/8	3 3/4	5/8	1	1.020	3 1/4	2	2 7/16	0.630	.05250
6	2.169	2.501	6 1/8	5	3/4	1 1/4	1.270	4 3/8	2 1/2	2 5/8	0.626	.05216
7	2.815	3.283	9	7 3/4	1	1 1/2	1.520	7	3	...	0.625	.05208

regular taper shank and used for scribing the size and location of the tang of the "Stantool" shank.

The accompanying table gives the exact dimensions for all sizes of the new standard. Special sockets and sleeves are, of course, required, to adapt these tools to drill presses now in use. The makers furnish these sockets and sleeves with an outside taper to fit the spindles, and an inner taper suitable for the new shank. They are also made with the new taper both outside and inside. These latter interchange or nest into each other.

The use of a new standard, made stiff enough to begin with, would seem to be a logical way out of the broken tang difficulty.

JAEGER AUTOMATIC FRICTION CLUTCH

One of the many disadvantages experienced with the ordinary design of automatic pin clutches, such as are extensively used on power presses, is the heavy blow against the clutch pin, a fact which quite often causes injury to some parts of the clutch mechanism, and is accompanied by expensive delays while the broken parts are replaced. In order to overcome the difficulty of breakages, many press builders have designed their clutch parts very heavy, giving the clutch mechanism a clumsy appearance and, sometimes, a slower action.

The expansion ring C is originally turned larger than the recess in the fly-wheel. It is then cut open, pressed together, and then turned to fit the diameter of the recess, so that when laid inside of the recess and permitted to expand, it will closely fit the recess and at the same time press against the walls. Due to this pressure, the expansion ring will follow the fly-wheel when the latter rotates, whenever the stop F, acting against the pin G and operated by the foot-treadle, is removed; but when the stop F is in the position indicated in Fig. 1, the expansion ring C is prevented from rotating with the fly-wheel, and contracts so that the friction between the ring and the fly-wheel is reduced to a minimum.

It will be seen in Fig. 1 that the expansion ring has on the inside two projections. The wedge D rests against one, and the other has the same radius as the eccentric B on the shaft, there being only a very small clearance between the ring and the eccentric when the former is expanded, and no clearance at all when it contracts. A small spring H holds the wedge against the inside of the expansion ring.

The operation of the clutch is as follows: The fly-wheel runs continuously, but crank-shaft A does not rotate when the clutch is not in operation. When a stroke of the press is required, the operator, by means of a foot-treadle connected with the stop F by the link K, releases the expansion ring so that it follows the fly-wheel, thereby forcing the

wedge D between the inside of the ring and the eccentric, and imparting motion to the crank-shaft A. The expansion of the ring is still further increased by the wedging action of D, so that practically a positive drive is obtained. When the treadle is released, the stop F slides up in the position shown in Fig. 1 and the pin G strikes against the stop and prevents the ring from following the fly-wheel any further. The experiments undertaken with the clutch show that the blow against the pin is but slight, as the momentum of the shaft, pitman and other moving parts quickly releases the wedge and permits the ring to contract. The projection at
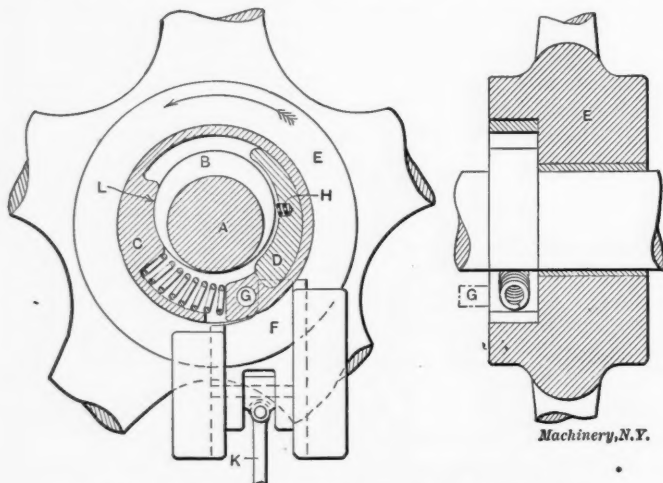
Fig. 1. Jaeger Automatic Clutch applied to a Power Press

L at this time also acts as a brake, stopping the crank-shaft at its highest point. If the foot-treadle is released immediately after being depressed, only one revolution will result.

The engagement is practically instantaneous as the clearance between the eccentric and the wedge is made as small as possible. An incidental advantage of this clutch is that the fly-wheel can be brought very close to the frame of the machine which, of course, is very important. A great many clutch designs make it necessary to place the fly-wheel a considerable distance from the frame and the bearings, thus producing bending stresses, and requiring larger shaft dimensions. A special brake acting on the crank-shaft is avoided. The design is very simple and reduces the cost of the clutch mechanism to a considerable extent. There is
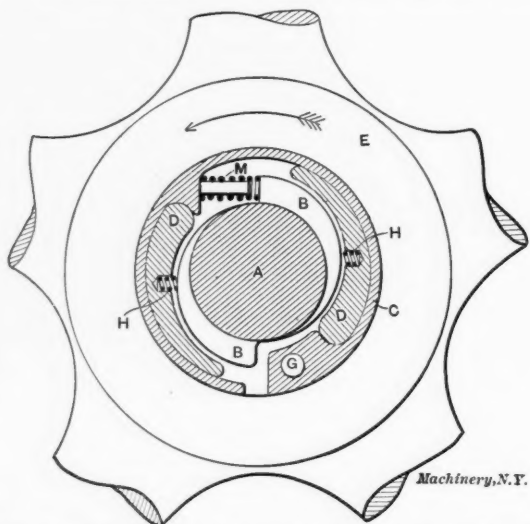
Fig. 2. Variation of Design of Jaeger Automatic Clutch, as used on Heavy Presses

nothing in the design of the clutch that is liable to get out of order or break, and the experiments undertaken show that the efficiency of the design is very satisfactory.

In Fig. 2 is shown a modification of the design intended for heavy presses. Here two wedges are provided instead of one, and the eccentric or cam on the crank-shaft is provided with a double rise. In order to provide for a stop for the crank at the right position a spring M is provided, inside of which is placed a small rubber cylinder. This cylinder prevents the spring from bending sideways and at the same

time acts as a final stop if the momentum is greater than that which will be taken up by the spring itself. The clutch is not limited to applications to presses only, but can, slightly modified, be used for a great many purposes where quickly releasing clutches are required.

BUFFALO FORGE CO.'S HAND I-BEAM AND CHANNEL PUNCH

While the tool here illustrated is a hand punch, it is designed, as a glance at its proportions will show, for far heavier work than is ordinarily considered feasible for hand operation. It will quickly and easily pierce a ½-inch hole in a ½-inch plate. Its maximum capacity by hand operation is for 1-inch holes in ½-inch plate. This would require a dead weight of about 40 tons on the plunger, considering the shearing strength of the material being punched as being 50,000 pounds to the square inch, which is about that found in the steel ordinarily used in bridges and similar structural work.

In the first place the construction of the frame is notable. It is composed of two sides of armor plate, rigidly bolted and
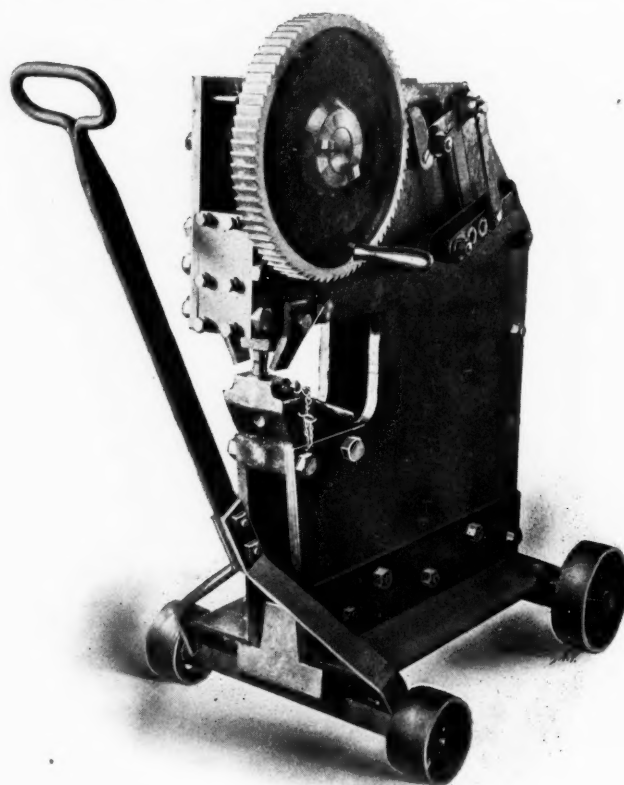
Hand-operated Punch of Large Capacity with Armor-plate Frame

riveted together in a box form of construction. The planed sides of the frame form guiding surfaces on two sides of the plunger, while the main guides are bolted between the sides and have adjustable gibs, which assure the permanent alignment of the punch and die. The die holder is a steel casting of a style designed to adapt it to working on the webs of channels, I beams, etc. It is mounted on the frame, and bolted on an extension machined to fit the frame space.

The great force which this hand operated punch is capable of applying is due, of course, to the construction of the operating mechanism. This consists of a combination lever, ratchet wheel, and crank mechanism, which will be easily understood from a study of the engraving. It gives a leverage of 2,200 to 1 from the end of a 6-foot lever to the shearing edge of the punch; this does not include the power lost in the friction of the working parts, which is small for a machine of this kind. The lever bearing studs are bolted to the frame, making a very rigid support. The socket in which the lever is inserted is provided with three holes for the connecting links to the secondary lever, so that a movement of 1, 2 or 3 ratchet teeth for each stroke is obtainable.

The ratchet wheel is cut from solid steel, and is hardened. It can be turned by a convenient handle to quickly adjust

the punch to the work, and to run it back again as well after the completion of the operation. The plunger crank-shaft, on which the ratchet wheel is pressed, is supported by flanged bearings bolted to the main frame. The throw of the crank-shaft is ¾ inch, and the motion is transmitted to the plunger head by a steel one-piece connecting rod the full width of the frame space, bored from the solid and bronze bushed.

This is believed by its maker, the Buffalo Forge Co., Buffalo, N. Y., to be the only punch press with armor plate frame made in the country. Its portability, in connection with its great capacity, should make it a useful tool in many structural operations. As may be seen, heavy angle plates are riveted to the frame on both sides, making a substantial base plate when it is desired to mount it permanently. Otherwise it is provided with a truck for portable use. It weighs about 1,000 pounds.

ST. LOUIS MACHINE TOOL CO.'S GRINDING MACHINE

The plain grinding machine, or grinding head, is so simple a piece of mechanism that it is no wonder that little thought is ordinarily given to its construction. There is no complicated mechanism, and the parts required are few and simple. Nevertheless, it is possible to put thought into the design of a machine as simple as this, as will be realized from a study of the accompanying illustrations, which show one size of a line recently placed on the market by the St. Louis Machine Tool Co., of St. Louis, Mo.
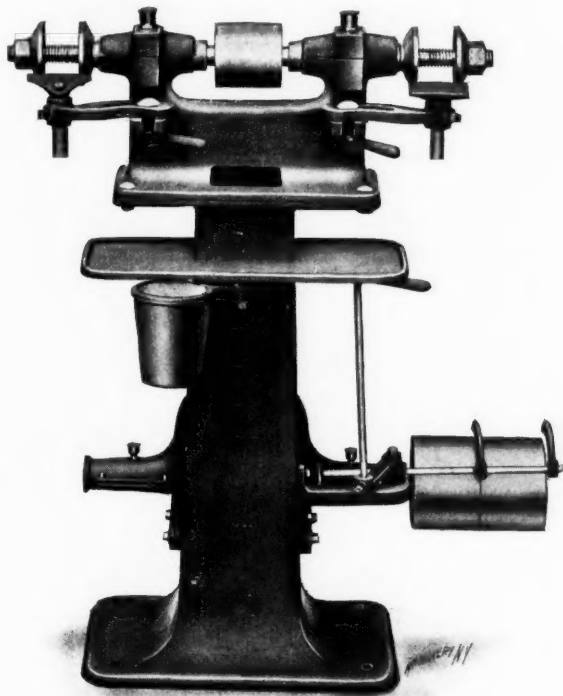
Fig. 1. Front View of the St. Louis Grinder

The points of advantage claimed for this grinder relate both to the workmanship and the design. Considering first the construction of the heads, the arbors are of 50 point carbon steel, with square threads coarser than standard, giving a strong and quick acting screw. The arbors for each size are of larger diameter than usual. The boxes are lined with a high grade of anti-friction metal, and are provided with oil reservoirs and felt oilers with a length four times the diameter of the arbor. The bodies are unusually long, extending out for their full size beneath the bearings, giving the latter a very rigid support. The arms supporting the rests are curved. This permits the use of a shorter fork than when the straight rest arms are used. This is very advantageous when large work is to be ground.

The column is of new design, being large and well proportioned to agree with the service it is called on to perform. The pan is 4 inches below the base of the machine, allowing more room than usual. All of the batter or slant of the column is at the back, thus setting the head as near the front of the base as possible, giving the tool somewhat the appearance of being braced toward the operator.

The column is furnished either with or without a self-contained counter-shaft. The machines shown are provided with this counter-shaft, which is the most interesting feature of the whole machine. The lower half of the boxes (see Fig. 3) are cast integrally with arms extending backwards the full depth of the column, being pivoted at the rear end. Each arm is also clamped to the column at the side by a screw passing through an elongated slot. The top halves of the boxes are cast in one piece and connected by a strong yoke which passes over the driving pulley. This yoke is provided with a lug passing beneath a corresponding projecting lug on the column, into which an adjusting screw is tapped. The driving belt passes over the large pulley at the base of the counter-shaft up back of the machine, over the spindle pulley and down through a hole, into the middle of the column to the pulley again. The tension of this belt tends to draw the driving pulley and its shaft upwards, bringing the yoke against the adjusting screw. By screwing down on this, the counter-shaft is

Fig. 2. Side View of the Grinder, showing Counter-shaft

swung downward upon its supporting arms and the belt tightened. The screws passing through the slots in the arms provide means for holding the adjustment once it is obtained. This tightens the driving belt and the belt from the main line-shaft at the same time. The belt shifter is conveniently located, as shown, it being unnecessary to reach overhead for it as usual.

This arrangement gives several advantages over the separate counter-shaft from the ceiling. One of the most obvious is the avoiding of the necessity for mounting the counter-shaft on the ceiling. Another is the advantage of bringing
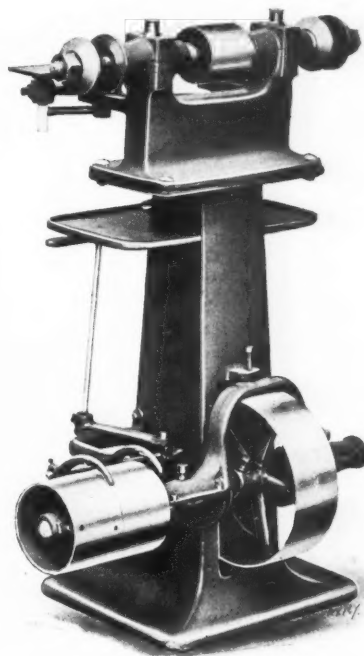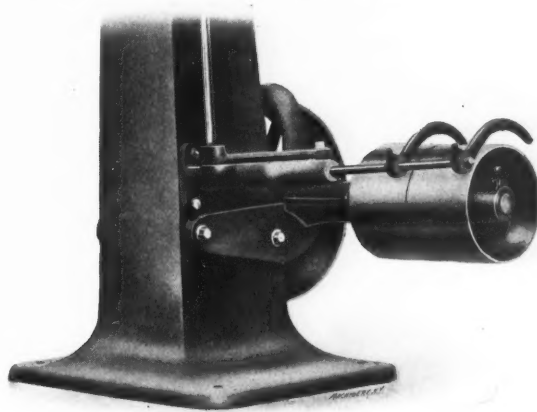

Fig. 3. Detail View of Belt Tightener and Shifter

the driving belt down in an out-of-the-way position, which is often a great convenience in handling large work. The most important advantage, however, is the smooth running of the wheels which is the result of the direction of the belt pull, this being such as to draw the spindle down against the frame of the machine, instead of up against the caps.

A short belt on a machine of this kind without a belt tightening device is impracticable. The only objection to the use of short belts is the matter of keeping them tight. In long belts the elasticity serves to allow considerable stretch without affecting the belt pull seriously. In short belts,

however, it is necessary to take up the stretch as fast as it occurs by some simpler means than by cutting and resplicing the belt. The use of the adjustable swinging supports for the counter-shaft does away with the great difficulty hitherto met with in furnishing a satisfactory self-contained counter-shaft.

These machines are made in five sizes, for work from the smallest to the heaviest which the workman is ordinarily called on to perform on a grinding wheel stand of this type.

TWENTY-FOUR-INCH FAY AUTOMATIC LATHE

The Fay Machine Tool Co. of Philadelphia, Pa., makes an automatic lathe especially adapted to the performance of turning operations on castings in large quantities. To the 14- and 18-inch swing sizes previously built, the makers have recently added the machine with a 24-inch swing shown herewith.

Without going minutely into the mechanism, the machine may be described as follows: The work spindle is driven by Hindley worm gearing from the high speed shaft extending across the top of the head-stock. This shaft is belted at the rear side to the counter-shaft, and at the front side to the feed-driving pulley at the left-hand end of the bed. This latter is geared to a longitudinal shaft carrying a series of cams

The large machine here shown swings twenty-four inches over the ways, eighteen inches over the carriage and will take thirty-six inches between centers. The automatic feed of the main bar and its carriages is fourteen inches. The provision for turning between centers is unique in automatic machines, and permits the production of a quality of work comparable with that produced on the engine lathe. One operator can attend several machines, or can run one of these in combination with work on a regular lathe.

The 5-step cone pulley shown in Fig. 2 was turned in two operations, roughing and finishing in forty-two minutes. This included turning and crowning the five steps, and facing both ends of the pulley. The crowning was done by suitable templets acting on the carriages attached to the main bar, as described. Facing down the ends was effected by tool holders on the rear bar.

IMPROVED MURCHEY AUTOMATIC OPENING DIE HEAD

The machine shown in Fig. 1 is a double-head pipe and nipple threading machine, made by the Murchey Machine & Tool Co., 4th and Porter Sts., Detroit, Mich. This machine follows the general lines of the older design built by the
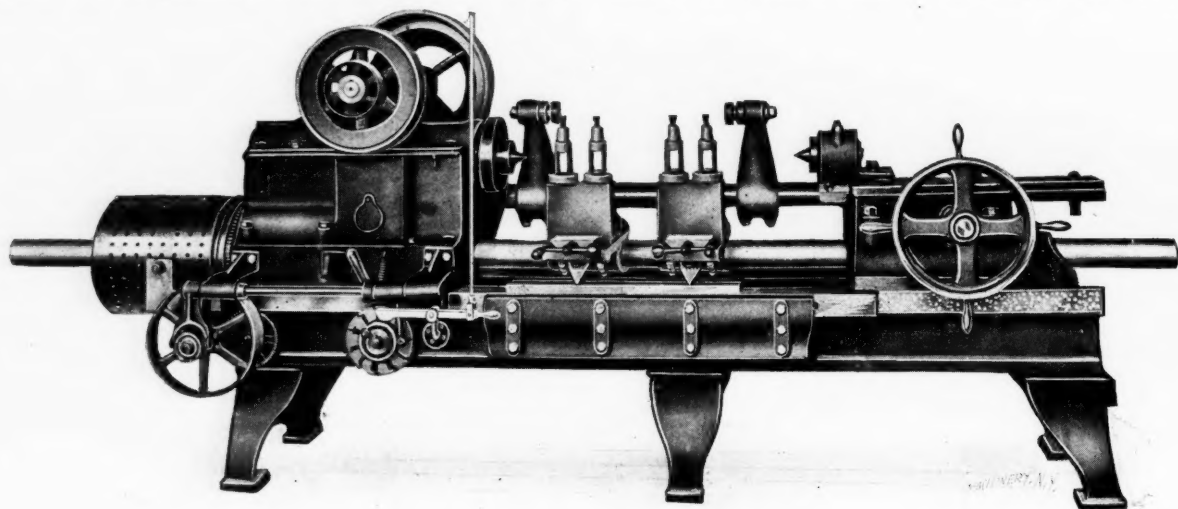

Fig. 1. An Automatic Lathe for Turning Pulleys, Gear Blanks, etc., on Centers

controlling the cutting tools. By means of a clutch mechanism operated by adjustable dogs, the cam shaft may be given a slow feeding movement, or a rapid idle movement, over any desired portion of its periphery.

Two heavy bars extend the length of the machine, and on these the various carriages and tool holders are mounted. Each of these bars is controlled by the cam shaft, both as to longitudinal movement and the rocking movement about

Fig. 2. A Cone Pulley, which was roughed out and finish-turned Complete in Forty-two Minutes

their axes. The rocking movement for the main bar at the front is controlled by a templet on the slide at the front of the bed, on which the outer ends of the carriages rest. This templet may be given any desired shape, which will be copied by the tool as the bar is fed longitudinally. 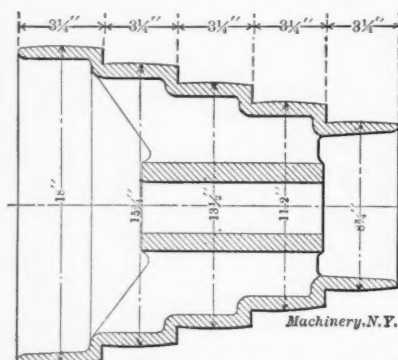On the other hand, if desired, the bar may be held against longitudinal movement while the slide carrying the templet is fed to the right or left, by means of its connection with a cam roll operated by the drum cam shown at the left of the machine. Cams of any required shape may be bolted on this drum to operate the former slide or the tool bar at the rear. The latter is rocked by a cam beneath the head-stock, while the main tool bar is operated by an internal cam surface within the cam drum.

makers, with the exception of the die heads, which are of radically new and improved construction. The mechanism of this new die head will be understood from a study of the line engravings, Figs. 2 and 3. Its purpose is to furnish a die head of rigid construction, wide range of adjustment, and strong, simple construction, and one that will operate readily and automatically and will preserve its accuracy through a long period of use. As may be seen, the head is composed of comparatively few members, and there are also few wearing parts and no light and delicate pieces in the mechanism.

The body A, which is of strong close-grained cast iron, is pressed on and keyed to the spindle B of the machine. In the face of the body are milled four large T-slots, carrying the steel die blocks C. These, in turn, are drilled and slotted to receive the dies D and the bearing pins E. These bearing pins are closely fitted in the holes in C, into which the slots for the die blocks are cut, so that there is a solid backing for the latter against the thrust of the cut.

On the hub of the body A slides a collar F. This is provided with lugs which are milled, drilled and reamed to form pivots for the die levers G. These latter are restrained from outward movement by a tapered bearing on the inner rim of the adjusting shell H. This adjusting shell is threaded to the collar at the rear end as shown, and is fitted at the front end to an internal flange on the rear face of the body A. When it is screwed in or out, the bearing of its taper surface on the four die levers G adjusts them inward simultaneously, or allows them to move out simultaneously as the case may be. These die levers bear at their front end on a seat cut to receive them on bearing pins E. When the sliding collar is moved to the right from the position shown in Fig. 2, the

ends of the die levers slip off of the seats on the bearing pins to a lower position, when the spring J forces the pins E, die blocks C and dies D outward, thus opening the dies and releasing the work. When the adjusting shell is moved to the left, levers G ride up on the cam surface onto the upper bearing on pins E, closing the dies. The turning of the adjusting shell H evidently affords means for setting the dies accurately to any desired diameter within the range of the adjustment.

The sliding collar F is moved to the left to close the dies by hand through a lever connection with the handles shown between the two work-slides in Fig. 1. The die is opened automatically when the desired length of thread has been cut. This is done through the reaming mechanism shown in Fig. 3. It will first be necessary to describe the operation of this mechanism in reaming a pipe. The reamer holder K is of malleable iron with a squared socket for receiving the squared pipe reamer shanks. The reamer is held in place by a single set-screw. The holder is supported on rods M, which pass through holes in the body A. It is free to move outward, but its backward movement is resisted by plunger N and spring O. The latter may be compressed to give more or less tension by means of threaded adjustment collar P (seen also on the
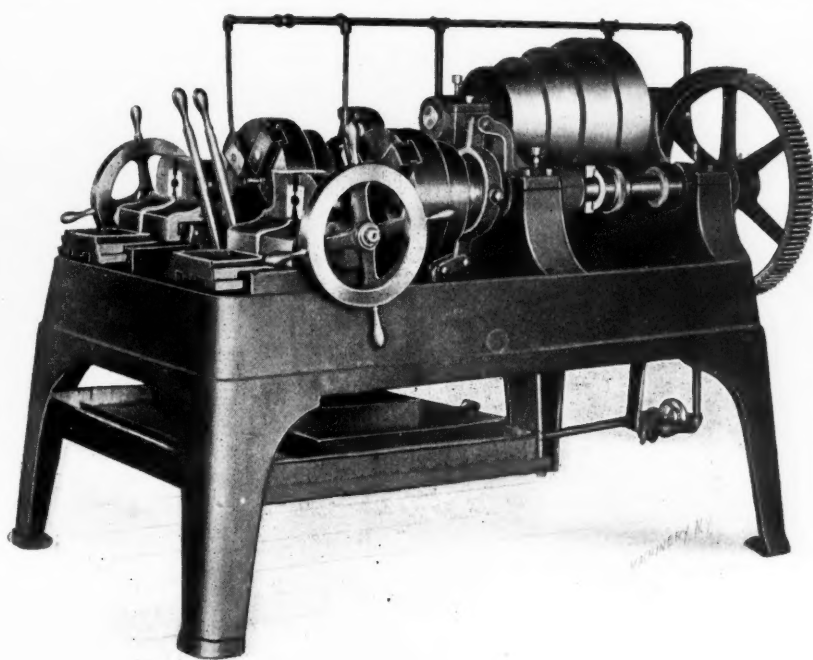

Fig. 1. Murchey No. 2 Pipe and Nipple Threading Machine equipped with Improved Opening Die Heads

spindle between the head-stock bearings in Fig. 1) which bears against collar Q and plunger R, furnishing the rear abutment for the spring. After the work has passed far enough into the dies to secure a good hold on the thread, the continued feeding forward of the pipe brings it in contact with the
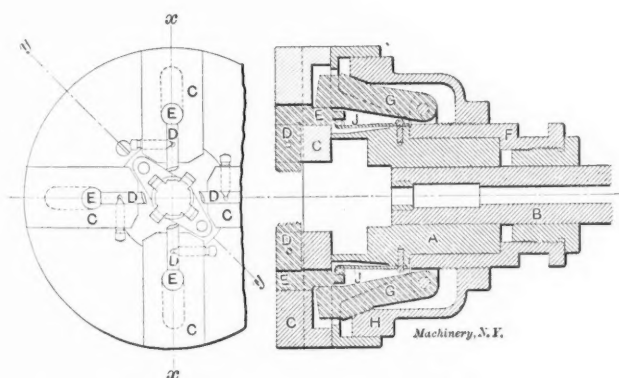

Fig. 2. Face View of Die Head and Section on Line x—x, through Die Blocks, with Reamer Removed

reamer L, pressing it back against plunger N and spring O, thus giving sufficient pressure for taking the chip. Owing to the construction the extra tension which may be applied by adjusting collar P affects the thread only when the work is

well through the dies, where a heavy chip will not cause a thin thread.

The automatic opening of the dies is effected by the longitudinal movement of reamer holder K, caused by the pressure of the work on the reamer. This forces back K and rods M

Fig. 3. Section on Line y—y of Fig. 2, showing Reaming Mechanism

against sleeve S, which is threaded into sliding collar F. As F is thus forced backward, levers G are withdrawn from their seats on bearing pins E, allowing the dies to open. By screwing sleeve S in or out, the length of the thread on the work can be shortened or increased. Spring O being set up tight enough so that the reamer faces the end of the pipe, it will be seen that the stop movement is governed by the end of the pipe itself, so that the threads come to a uniform length. Shoulders are provided on reamer rods M, which strike against the shoulder on the sliding collar F, in case S is adjusted out too far. When the die head is open, the reamer holder with the rods may be drawn out, allowing long or "running threads" to be cut.

The adjustments for this die holder are few, simple and quickly made. They are the adjustment of shell H for the size of the thread, of sleeve S for the length of the thread, and of sleeve P for the depth of internal reaming. The large amount of adjustment of sleeve H makes it easily possible to re-hob dies in this head. The workmanship is of a high grade, the tool being made with jigs and fixtures throughout on the interchangeable plan. The die blocks are of case-hardened machine steel, the bearing pins E are of tempered steel, and the bearing levers G are of tool steel. Attention has been given to the quality of the steel material in the dies, which is the best obtainable.

The double nipple and pipe turning machine shown in Fig. 1, equipped with the die heads just described, has a capacity for work from ½ inch up to 2 inches inclusive.

WALTHAM MULTIPLE SPINDLE DRILLING MACHINE

The accompanying half-tone shows an addition to the line of precision machine tools built by the Waltham Machine Works, Waltham, Mass., which we have illustrated from time to time. This particular tool is a multiple spindle drilling machine, built on the lines of the larger tools used for drilling holes in cylinder flanges, machine frames, etc. The idea here, however, is reduced to the smallest scale on which we have ever seen it used.

The frame of the machine is in two parts; one is a base, carrying the work table, and the other is a stand mounted on the base, carrying the driving mechanism for the spindles. The drive shafts are evenly spaced about a central gear, which is connected with the double driving pulley shown at the top. These gears are enclosed and accurately cut, so that a very high drilling speed is obtained with practically no noise. The lower, or drill spindles are held in interchangeable cast iron blocks, accurately bored to the desired location of the holes. As these blocks can be reversed, it will be seen that the holes may be drilled from either side of the work; or, in the case of clock plates, the upper and lower members may each be drilled from the inner face. By using short drills, holes may be accurately located without the use of a jig, and the ma-

chine can be used for reaming and countersinking holes already drilled or punched. Provision is made for using a jig, however, if desired.

An important feature in the construction of this machine is the extremely close spacing with which the holes may be drilled. This may be less than 0.200 inch center distance. This is accomplished by the use of special ball and pin joints. The joints and all the spindles are of hardened steel, the latter having bronze bearings which can be easily replaced

A Multiple Spindle Drilling Machine, built on a Minute Scale

when worn. The connections between the driving and the drill spindles are two or three times as long as is usual in machines of this type, thus making the angle very slight, and materially reducing the wear on the joints.
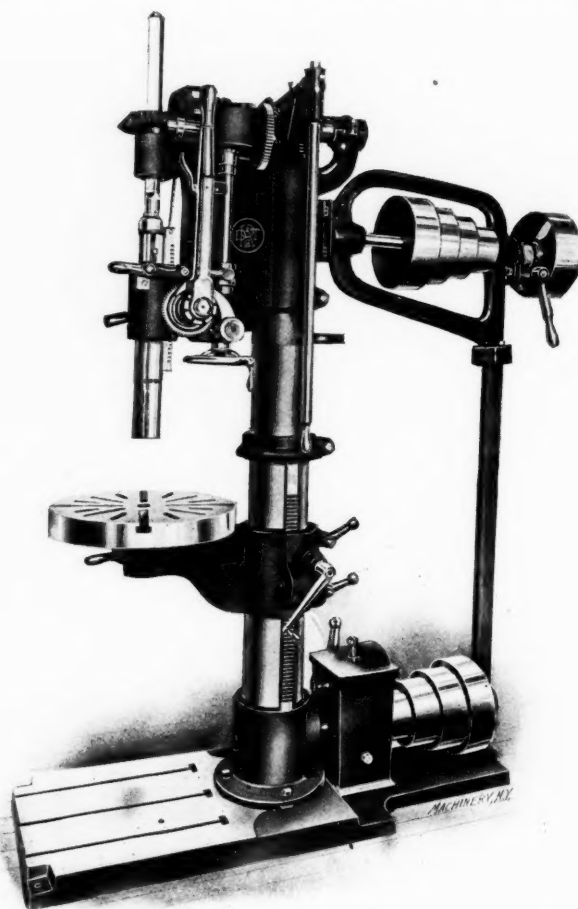
The table carrying the work is operated either by a hand wheel, or a lever connected to a rack and pinion. An adjustable stop is provided to regulate the depth of drilling. There is also a screw adjustment for setting the vertical position of each spindle separately.

This machine is made in two sizes. The larger, which is particularly intended for clock and similar work, weighs 240 pounds, and is made with any number of spindles up to 14. It will drill to any position inside of a 6-inch circle. The smaller, or watch size, weighs 50 pounds, and can be built with any number of spindles up to 8. It will drill anywhere inside of a 3½-inch circle.

ROBERTSON DRILL & TOOL CO.'S 21-INCH DRILLING AND TAPPING MACHINE

The accompanying illustration shows a 21-inch drilling and tapping machine made by the Robertson Drill & Tool Co., Dept. 5, Buffalo, N. Y. This resembles somewhat in its general lines the 21-inch upright drill illustrated among the new tools in the May issue of MACHINERY. The driving mechanism, however, is entirely different, and the machine is provided, in addition, with a self-contained tapping attachment.

Contrary to the usual construction, the driving cone on the countershaft is placed at the top of the machine, with the driven cone at the base. Four-step cones of large diameter

for a 2¾-inch belt are used. The back-gearing is enclosed in the casing shown on the lower cone shaft. The back-gearing may be thrown in and out while the machine is in motion. From this point the power is led to the top of the machine again by miter gearing and a vertical shaft passing through the center of the column. At the upper end it is connected through reversing miter gears with the usual horizontal driving shaft. The long lever which hangs from the top of the column controls the clutch playing between these miter gears, and thus serves to reverse the motion of the spindle, or stop it, as may be required. The clutch provided on the driving pulley of the countershaft is not used in the operation of the machine, being employed only when the workman starts his job or finishes it.

The feed is geared and has 24 changes. It may be operated by a wheel or lever, as well as by power. An automatic stop is provided. The spindle is 1¾ inch in diameter, and is driven by its squared shank, which fits a corresponding hole in the driving gear, as explained for the machine described in the May issue. The gears are all cut from solid metal. All the bevel and miter gears have planed and generated teeth.

Robertson Drill Press with Self-contained Tapping Mechanism

The racks are of steel cut from the solid. All clamps and adjustments are furnished with permanently attached handles.

The height of the machine over all is 77 inches. It occupies a floor space of 18½ by 58 inches. The table is 18 inches in diameter and the machine drills to the center of a 21¾-inch circle. The net weight is 1,450 pounds.

RECENT ADDITIONS TO THE BROWN & SHARPE LINE OF MACHINISTS' TOOLS

The ten accompanying illustrations show the latest additions to the line of machinists' tools made by the Brown & Sharpe Mfg. Co., Providence, R. I. While some of the additions relate principally to improvements in design of older tools, others are radically new in principle. All of them are of interest.

Universal Surface Gage with Fine Adjustment

This firm has been making a universal surface gage for some time. The principal feature of its construction is the fact that the spindle can be swiveled about a horizontal axis

and is so mounted on the base that it can project down past it in a slot provided for the purpose, if desired. The base is provided with a V-groove for use on cylindrical surfaces. For small work the spindle can be removed, and the scriber inserted in a hole provided for it in the clamp.

The new gage preserves all these features, and gives the added advantage of a fine adjustment by means of a knurled screw at the top of the spindle clamp. Turning this brings the spindle and the scriber accurately to the height desired. It has a distinct advantage over other devices intended for

Fig. 1. Surface Gage with Micrometer Adjustment

the same work, in that the movement is always vertical, no matter what the position of the spindle or scriber. Two gage pins at the rear of the base can be pushed down so as to line the tool up against the edge of a plate, or the side of a T-slot. The scriber may also be used below the base as a depth gage. This tool is made with 9-, 12-, and 18-inch spindles, and with light or heavy base.

Standard Caliper Gages

The Brown & Sharpe standard caliper gages have been furnished for many years with internal and external surfaces on the same piece, for all sizes up to 3 inches; larger than that the gages have been made separately for external or
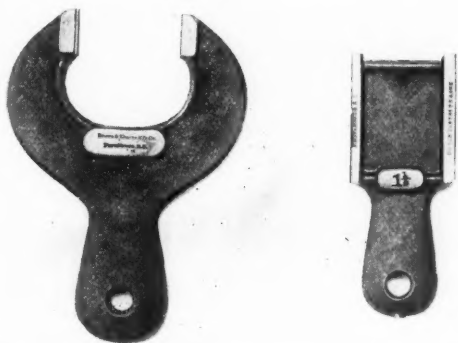
Fig. 2. Standard External and Internal Caliper Gages

internal measurements. To meet the demand for tools for use where measurements of one kind only, either internal or external, are to be taken, separate gages with handles are now furnished for all measurements between ¼ and 3 inches. Furnishing them separately instead of in one piece has a distinct advantage whether both are to be used or not, as it enables one to be employed as a standard gage for testing the other.

A Large Automatic Center Punch

The well-known automatic center punch made by this firm is now furnished for heavy work in a size 11¾ inches long and 1⅜ inch in diameter. This heavy tool has found con-

siderable use in many ways not thought of at the time of the introduction of the smaller size a few years ago. It is employed, for instance, in rolling mills for testing the hardness of metal. The hardness is judged by the size of the impression made, in something in the same way as in the Brinell test. It may be used, as well, for testing the depth of case-hardening, or for laying out heavy work for drilling.

Among the miscellaneous uses which have been found for the automatic center punch may be mentioned its employment by amateurs in making art objects of hammered copper or brass. For this work it has been found much easier to use than the usual punch and hammer, requiring considerably less exertion. It has been recently employed also in the makers' automatic screw machine, where it was desired to punch a square center in the end of a piece of work held in the chuck. It was not found feasible to bring the turret up forcibly enough to make the desired impression. To overcome the difficulty, the striking mechanism of one of these hammers was employed in the turret tool. The latter was brought up with the punch bearing on the work, thus compressing the striking spring of the tool. The spring plunger, being released by this movement, was forced against the head of punch, making the desired impression the same as in the hand-operated tool. The spindle of the screw machine was stopped and held fast for this work.

Tubular Inside Micrometer Gages

These gages are a new design, intended for use in manufacturing operations for measuring inside diameters from 8 to 40 inches. A particular advantage in their construction is the fact that they are of tubing, making them very light and convenient to handle, especially in the longer size. They are used in taking inside measurements as in measuring
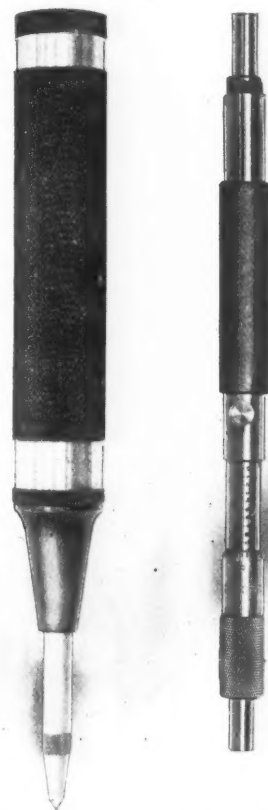

Fig. 3. An Automatic Center Punch of Unusual Size

Fig. 4. Tubular Inside Micrometer Gage

rings and cylinders and in setting calipers, comparing gages, and in doing other work of a similar nature.

The gage consists of a tube or body, provided with a 1-inch micrometer head at one end, and a fixed measuring point at the other. The measuring points are hardened and ground spherically, thus adapting the gage for measuring parallel or curved surfaces. Provision is made for adjustment to compensate for wear, and a clamp screw is provided for preserving the setting after it has been obtained. A fiber handle prevents the hand from coming into direct contact with the tool, and thus varying its temperature.

Each gage has a movement of 1 inch, and the entire line embraces 32 different sizes, covering the range from 8 to 40 inches.

Universal Indicator

Fig. 5 shows an indicator of new design, of which the distinguishing feature is the fact that it reads movements in any direction—up, down, sidewise or inward. The point which bears against the work is of steel, hardened and ground spherically, thus allowing pressure to be brought upon it from any direction. A scale on the top of the case registers the movement by means of a pointer. This scale is graduated to thousandths of an inch and reads to 0.007 inch either side

of zero. The shank is of hardened steel, and is designed to be held in the tool-post of a lathe. By means of a swivel joint at the end of the shank, the head may be adjusted either above or below the center within a range of 30 degrees on either side.

This tool will be found useful in setting centrally a point or hole in a piece of work to be operated on in a face-plate or chuck. It may be used, also, for testing lathe centers, shafting and other work held between centers, inside and outside diameters of pulleys, cylinders and similar work; and may be employed in testing finished machinery.

Heavy Micrometer Calipers

It has always been considered that the careful handling of fine measuring tools is one of the distinguishing marks of
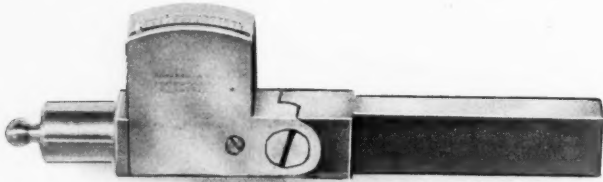
Fig. 5. An Indicator which reads in All Directions

a good workman; so the apprentice is always warned not to use a vernier caliper for a monkey-wrench, or a micrometer for a C-clamp. It is not considered good practice, as well, to use the micrometer as a snap gage with the spindle clamped fast. Whatever the case may be for the vernier caliper, the makers of the micrometer shown in Fig. 6 have concluded that there is a legitimate demand for an instrument which can be handled more freely and carelessly than the standard

Fig. 6. New Design of Heavy Micrometer Caliper

design of micrometer caliper. In consequence, these tools have been made with all parts of much greater weight, stiffness and bearing surface than have been hitherto employed.

The frame is of heavy I section, of a design which gives exceptional strength and rigidity. The spindle and screw are of larger diameter than usual, giving great stiffness and long life under adverse conditions, owing to the larger bearing surface for the threads. The screw is encased and protected from grit and from injury. Provision is made for adjustment to compensate for wear. The thimble is of unusually large diameter, so that the thousandths graduations are more distinct and easily read.

The clamp ring shown in the engraving securely locks the spindle in any desired position, and it is intended that the tool should be used freely when thus set. This makes it adaptable for use in the grinding room, where there is necessity for taking frequent measurements under these conditions. The construction of the tool is also such as to make it durable under the unfavorable conditions of water, grit, etc., found in this work. Each caliper is provided with a specially de-

signed ratchet stop. It is made in three sizes to measure up to 1 inch, from 1 to 2 inches, and from 2 to 3 inches, respectively.

Hardened Squares with Beveled Edges

In Fig. 7 is shown a hardened steel square with both edges of the blade beveled. This gives practically a line contact with the work under observation, making possible the detection of slight errors, and fitting the tool for use in the tool-room and on all classes of work where the requirements are most exacting.

Besides the provision of the beveled edges, these squares are made with all the care taken with the makers' well-known cast steel try-squares. Every precaution is taken to insure accuracy, the blades being at right angles to the beam. A recess in the beam at the base of the inner edge of the blade is an improvement in the construction which will be appreciated. This is a very desirable feature, as it enables the
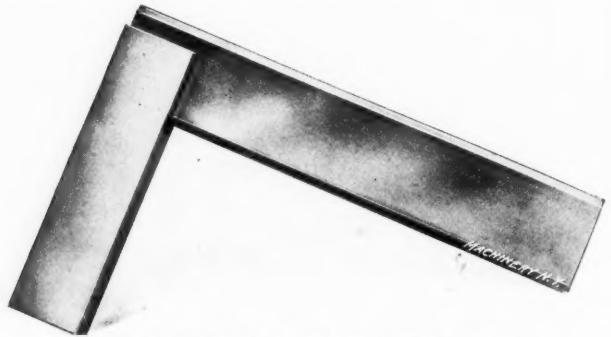

Fig. 7. Hardened Square with Beveled Edges

user to easily remove dust and dirt from the corner of the square and thus obtain accurate results on work having sharp corners. This tool is made in four sizes, of which the smallest has a blade 1½ inch long and a beam 1 9/16 inch long, while the largest has a 6-inch blade and a 4⅜-inch beam.

Height Gage Attachment for Inside Micrometer

The device shown in Fig. 8 is an attachment which may be used to convert the inside micrometer gage into a convenient height gage. The measuring rod is inserted upwards through the base and clamped securely by turning the knurled nut shown in the engraving. The micrometer is then adjusted and clamped to the upper end of the rod. When thus set, it will be found useful in obtaining the heights of projections on plane surfaces, the location of bushings in jigs, and other
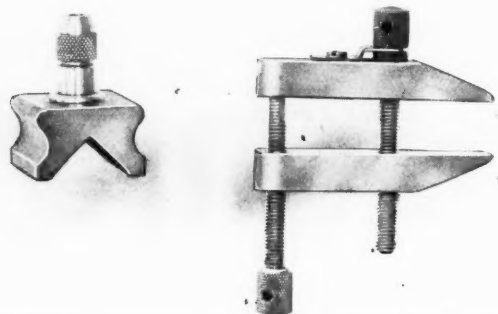

Fig. 8. Height Gage Attachment   Fig. 9. An Improved Toolmakers'
for Inside Micrometer   Clamp

measurements on work of a similar character. Its range of measurement is from 2 to 9½ inches or 50 mm. to 230 mm. The V-groove in the base adapts the gage for use on cylindrical work.

Improved Tool-makers' Clamps

The little clamp shown in Fig. 9 is of conventional design, with the exception of one improvement which greatly increases the handiness of the tool. This improvement is the provision of a spring or clip, entering a groove in the head of the inner adjusting screw. Its purpose is to prevent the sliding jaw from dropping when inserting or removing work. It will be found very convenient where a large quantity of pieces of the same size are to be clamped for drilling, as it holds the jaws at the required distance for removing or

inserting each piece, it being necessary to manipulate only the outer screw. These clamps are of steel, case-hardened. They are proportioned throughout to furnish great strength in a light and compact form. The jaws are rounded at the ends to allow clamping under a shoulder or into a recess. The screws are of as fine pitch as is consistent with strength, thus giving great clamping power. The engraving shows the smallest of the line, which ranges from a tool with a maximum opening of the jaws of from ¾ inch up to 2½ inches.

Two New Rules

The upper rule shown in Fig. 10 is graduated on one side to 64ths. As may be seen, the reading of these graduations has been greatly simplified by numbering every eighth line,
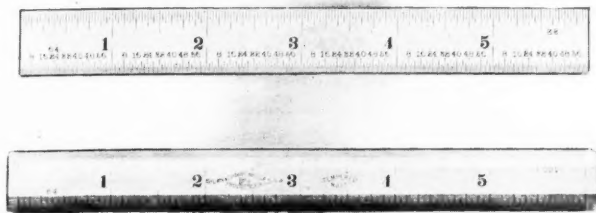
Fig. 10. Two New Rules

thus: 8, 16, 24, 32, etc. This makes the rule much more convenient and reduces the risk of error from a faulty reading.

The lower rule in Fig. 10 is provided with beveled edges similar to those furnished on the ordinary draftsman's instrument. This is intended, however, not only for draftsmen but for tool-makers as well. It will be found useful in laying out fine work, where close measurements are required. Beveling the edges brings the graduations closer to the work, insuring accurate measurements. This style of rule is beveled and graduated on both edges of one side only.

Both of these rules are furnished in a variety of lengths from 1 up to 24 inches.

THE "CISCO" HAND-POWER CRANE

The Cincinnati Iron & Steel Co., Cincinnati, O., is building the remarkably simple and rigid hand-power crane shown herewith. It is intended for general use in machine shops and industrial works of all kinds. It is very easy of action, and the workman requires but one hand in operating it.
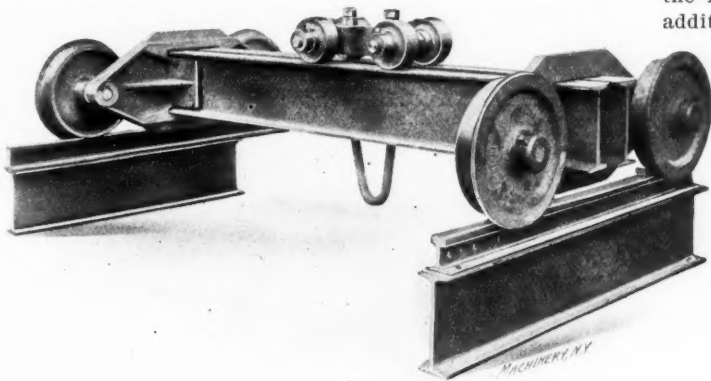

Fig. 1. The "Cisco" Hand-operated Crane

Fig. 1 shows the crane ready for use. The structure is composed of the two end trucks (see also Fig. 2), the cross beams and the trolley. The end trucks are solid castings, with pivots for the wheels, which are mounted in roller bearings. The cross beams overhang on both sides, so that in the case of an overload beyond the capacity of the crane, causing any part of the trucks to break, these beams would drop down onto the crane runway, preventing serious accident. Provision, not visible in the illustrations, is made for keeping the trolley from diverging from the straight line of travel. On

the hanging loop of the trolley are placed wheels revolving in a horizontal plane, and supported by collars and set-screws. These bear against the inner faces of the webs of the I beams on each side, thus furnishing a rolling guide.

It will be seen that this crane is so arranged that the purchaser can furnish the I beams himself, if desired, only the end trucks and trolley being shipped from the factory.

TUCKER POSITIVE LOCK COMPRESSION GREASE CUP

The engraving shows a grease cup recently designed by W. M. & C. F. Tucker, of Hartford, Conn. It is of the compression type. The new feature in its design relates to the positive lock against turning under vibration, which makes it particularly adapted to automobiles and other classes of machines that are subject to severe and continued jarring.

The cup itself is not higher above the base than the ordinary grease cup. The locking mechanism is placed on top of the cap in a handy position to operate. To unlock, the small cap is pressed down and turned to the right, when the cap may be screwed down as desired. If left unlocked, it will lock itself after the first quarter turn from vibration or other cause. To remove the cup for refilling, turn the small cap toward the left until

A Grease Cup which automatically locks itself against Vibration

it stops, reversing the movement for assembling again. The locking mechanism is covered, so that it is thoroughly protected from dirt and grit of any kind.

STOEVER 1909 MODEL PIPE MACHINE

The accompanying engravings show the most recent design of the pipe threading and cutting off machine made by the Stoever Foundry & Mfg. Co., Myerstown, Pa. The particular machine here illustrated has a capacity for threading and cutting off pipe from 2½ to 8 inches in diameter, inclusive. The improvements relate to provisions for giving a higher output and making the machine more convenient in operation as well. The style shown is belt driven, though it can be readily changed to use a constant speed motor, as may be seen.

The massive construction of the bed and head-stock has been retained. The spindle, as in the previous models, is provided with heavy three-jawed independent chucks at both the front and back ends, the rear chuck being furnished, in addition, with special grips for use on flanged work. These
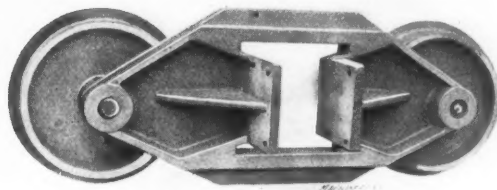

Fig. 2. Detail View of the Truck, showing the Simplicity of the Design

chucks are made in one piece, with the slots for the slides milled out of the solid. The internal gear drive of the front chuck has also been retained, with few changes in the design.

As may be seen in Fig. 1, all the speed changes of this machine are obtained from quick change gearing. The gear box is oil-tight, giving thorough lubrication to the gears, which are all cut from the solid. A single driving pulley is used. The five changes obtained in the gear box are doubled by the back gearing handle shown at the right of the box, giving ten separate speeds suitable for cutting either iron

or steel piping throughout the whole range of sizes for which the machine is listed. The bore of the spindle is sufficiently large to take extra heavy 8-inch fittings, which is its maximum capacity.

Fig. 2 shows a front view of the slide, with the new design of opening die head in place. This head slides on ways on the front of the stand, thus accommodating itself to eccentricity in the pipe and relieving the machine of the strain produced under these conditions on a rigid head. This naturally results also in far better threads. The adjusting mechanism for opening and closing the chasers and setting them to the desired size is simple and easy of operation. The dies are opened and closed by the lever above the head. This closes with a toggle movement, the three joints being in a straight line as shown, so that there is no possibility of digging into the pipe before the chasers are released. The hand knob for making the adjustments is directly in front of the operator, as is also the dimension scale on the face of the cam ring.

A unique provision of this die head, shown in Fig. 2, is the mounting of the steel front die ring on hinges, so that it may be swung open to facilitate the changing of chasers. This also gives free access to the head for cleaning it of any chips and grit which may have worked their way into the mechanism. If desired, the chasers may be removed when

Fig. 1. The Stoever 1909 Model, Geared Drive, Pipe Threading and Cutting-off Machine

the front of the slide is closed, as they can be withdrawn or inserted from the inside of the head, as well as by the means shown in Fig. 2.

The bottom of the slides in which the chasers travel are reinforced with hardened steel plates, thus keeping them true

Fig. 2. The Floating Die Head, with Face Plate thrown open for Changing Chasers or Cleaning Mechanism

at all times and insuring accurately cut threads. The cam ring is of interchangeable, sectional construction. The cams are of steel, inserted into the ring, so that replacement is possible at a low cost when a cam becomes worn or broken. The chasers are also interchangeable, to the extent that it is

possible to replace one without getting a whole set. They are numbered to correspond with the slots in the die ring, and any chaser purchased from the makers at any time may be used with other chasers of the same size, when mounted
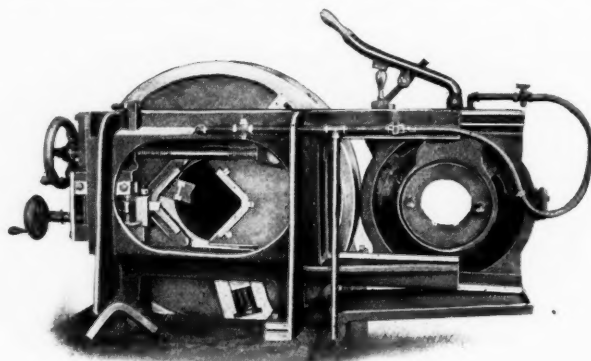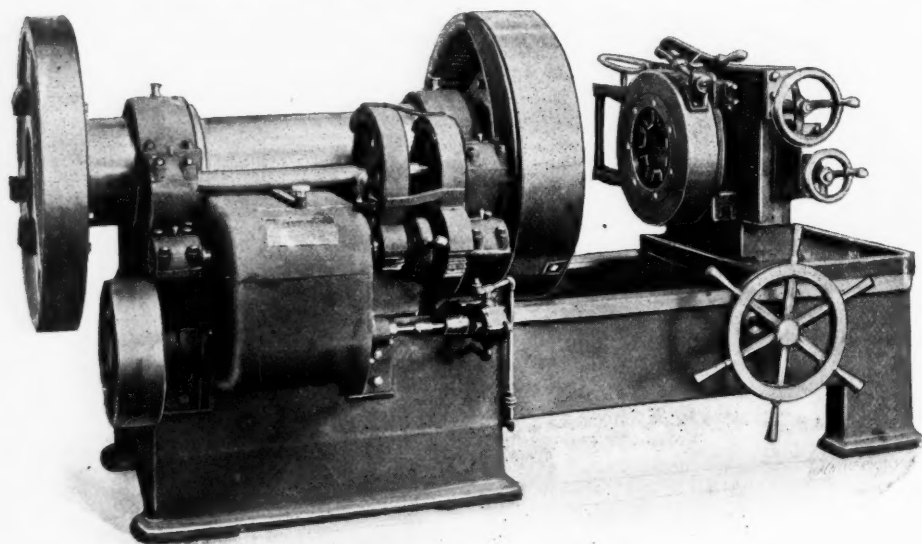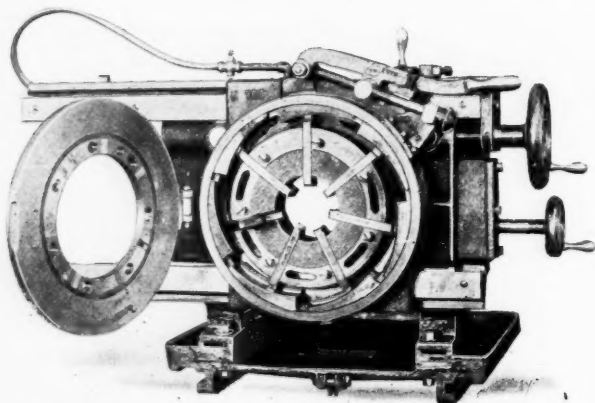

Fig. 3. The Die Head Moved to One Side, to permit Cutting Off Close up to the Chuck; note the Removable Jaws for the Steady Rest

in its proper slot. This provision is one of the noteworthy improvements in the machine.

Another feature to which special attention is called is shown in Fig. 3. Here it will be seen the die head is pushed out of the way and clear of the front chuck, allowing the slide to be brought up so close as to make the machine available for 3-inch nipple work. Another improvement, seen in this illustration, relates to the construction of the steady-rest slides. The wearing surfaces of these slides are interchangeable, and may be easily replaced by the operator when necessary, so that it is no longer necessary to await replacements from the factory in case of wear or accident. One of the removable wearing surfaces is shown lying on top of the slide in the engraving.

The oil pump for this machine is of the rotary type, and is fastened to the main driving shaft as shown in Fig. 1, thus insuring a steady and constant flow, irrespective of the diameter being machined. Fig. 3 shows the arrangement of the piping which, by means of the flexible tubing shown, directs the oil to the point of the cutting off tool and to the die head, by connections which adapt themselves to the varying adjustments of the machine.

This machine is one of a complete line, both of standard and automatic types, ranging in capacity from ¼ up to 12 inches.

THE KINKEAD SYSTEM OF ALIGNING SHAFTING

Long experience in the cotton mills of New England had convinced the inventor of the instruments herewith illustrated that the loss of power from friction is a serious item in large establishments, even when unusual pains are taken to keep the shafting in line and well lubricated. He therefore set to work to design instruments which would test the alignment of shafting more rapidly and more accurately than any at that time in use, thus making it possible to keep the transmission of a large plant in good condition at a minimum of expense. The devices herewith illustrated and described were the results of his study on the subject.

The apparatus comprises three instruments—the level shown in Fig. 1, the portable target shown in Fig. 2, and the fixed target shown together with the level and portable target in Fig. 3. The level is a special architect's instrument with an 11-inch telescope, provided with cross hairs and accurate adjustments. The glass magnifies twenty diameters, and is capable of handling an 800-foot line of shafting. The portable target is hung from the shafting by an ingenious jaw clamp,

which is one of the important features of the mechanism. This clamp which is operated by the spring and toggle mechanism shown, is so designed that the distance from the shafting to the center of the target is invariable, no matter what the diameter may be. This is very important on a long line, where it may be hung from a 1½-inch shaft at the driven end, and moved to a 12-inch shaft at the driving end without altering the height of the target. The jaws are of cast iron,
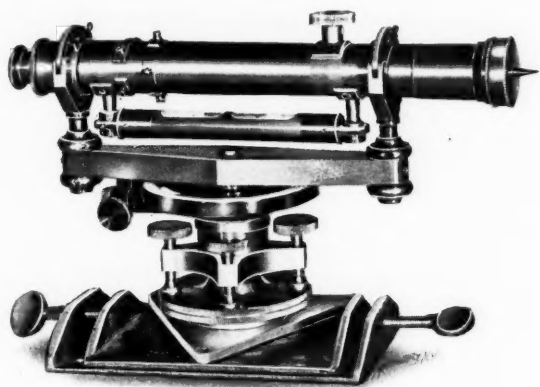

Fig. 1. Special Architect's Level, used for Lining up Shafting

nickel-plated. The spring which closes the jaws on the shaft is of steel. The target has a fine adjusting screw for vertical movement on the bow by which it is hung, as well as the rapid telescopic adjustment locked by the thumb-screw. The fixed target is mounted on a dead wall or other convenient support at the further end of the line from the level. It is provided with horizontal and vertical adjustments, and carries a lantern so that it may be used at night if desired.
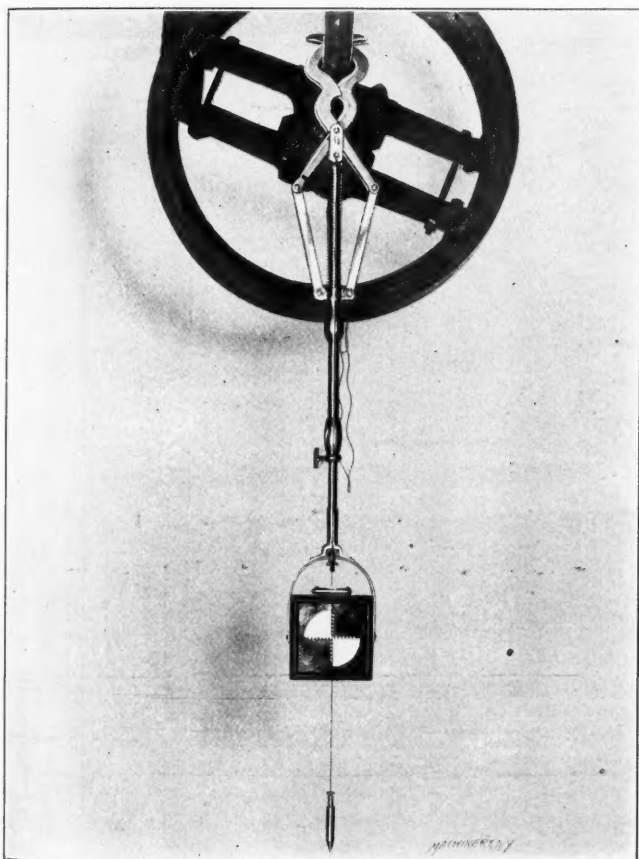
Fig. 2. Portable Target, with Self-adjusting Jaws for Gripping the Shaft

This apparatus is used as follows: First, the portable target is placed on the shaft at the end of the line where the operations are to be begun. The plumb bob is hung from a hook at the base of the clamp as shown in Fig. 2, and the center of the shafting is marked on the floor. At the same time the center line of the target face is lined up with the plumb line, and the spirit level is adjusted, if necessary, to read to zero, the spirit level being relied upon in the future operations to bring the target plumb. The target is then

moved a short distance away from this position, and the architect's level is centered over the spot marked on the floor. The telescope is then set to match the vertical center line of the target and the latter is again brought up close to the telescope and adjusted vertically until its center matches the indicating point on the cap shown in place in Fig. 1. The portable target is now removed, and the fixed target is set up on the dead wall or other suitable support at the further end of the line and adjusted in both directions to center with the cross hairs on the level. This target acts as a foresight, and, by comparing the level with it from time to time, it is possible to tell if anything has happened to disturb the adjustment.

In lining up the shafting, a sketch is first made, numbering each hanger, and giving a space to record the levels (whether high or low) and the lateral displacement (whether north or

Fig. 3. The Level, Portable Target and Fixed Target, the latter provided with a Lantern for Night Use

south, or east or west, if the line shaft runs north or south). The portable target is then placed on the shaft at the first hanger and sighted through the level. The edges of the sighting spaces in the target, it will be noticed, are notched to read to eighths of an inch both vertically and horizontally. By reading these on the cross hairs of the level the operator is informed as to the amount of displacement up and down or sideways. The chart record for the No. 3 hanger might read No. 3, ⅜ inch high, ¼ inch west.

After readings for all the hangers in the line have been put down on the chart, the latter is examined to see if any of the hangers are badly out. Sometimes where two or three are way out of line, trouble can be avoided by changing these first. It is usually best, however, to adjust the portable target at the furthest hanger and bring that shaft to line and level, and then so on, from hanger to hanger, one man making the adjustments as required by the chart, while the other checks them up as fast as made by sighting through the level at the portable target. If it should be found that there is a decided difference in level from one end to the other of a long line of shafting, it will not be necessary to bring it to the level. It can be graded uniformly from one end to the other by properly adjusting the leveling instrument.

Appropriate variations of this method of operation allow it to be used on shafting running beneath the floor, fastened in wall boxes, or running beneath the bench, as well as when

supported from the ceiling in the usual way. For shafting running beneath benches the target is used horizontally. Off-set supports are provided for special cases in which obstructions prevent the portable target from hanging vertically. The instruments will also be found useful in setting up counter-shafts, in lining shafts parallel with each other or with the main shaft, or in setting shafting at right angles.

It has been the experience of the makers of this apparatus, the Kinkead Mfg. Co., 7 Water St., Boston, Mass., that no line of shafting of the five hundred, more or less, which they have tested has been found in really good condition, even when lined up by millwrights skilled in the ordinary methods of doing this work. The loss of power in shafting is seldom less than thirty per cent or thereabouts. With reasonably good hangers this loss is reduced to fifteen or twenty per cent of the total load. This saving in power can be figured out to a saving in the coal pile for the ordinary plant which will make the use of the equipment decidedly profitable.

The operation of lining up with this apparatus is very rapid. It is possible, for instance, in ordinary work to test and line up 250 feet of shafting in three-quarters of an hour, by using two men. The apparatus does not require experts to handle it, as a little instruction will enable the intelligent millwright to use it as successfully as the engineer. The use of a lantern with the fixed target permits the work to be done as easily, rapidly, and accurately at night as during the day. This apparatus is being used in a large number of mills and factories, using anywhere from 300 to 10,000 feet of shafting.

LODGE & SHIPLEY CRANK-SHAFT LATHE

The accompanying engravings illustrate a set of lathe attachments of unusual interest. They were designed by the Lodge & Shipley Machine Tool Co., Cincinnati, O., for adapting their regular 22-inch patent head lathe to the work of turning the throws of four-cylinder automobile crank-shafts, for manufacturing in large quantities. This attachment is

gripped in a bearing in the chuck, having a hinged cap. It is centered and driven by the sliding jaw, whose forked opening embraces the cheek of the crank. This is most plainly shown in Fig. 3. The tail-stock chuck is a simple block of steel, bored for three bearings. The two end bearings are bronze bushed and tapered, and either of them may be used for either the taper plug bearing in the tail spindle, or for the
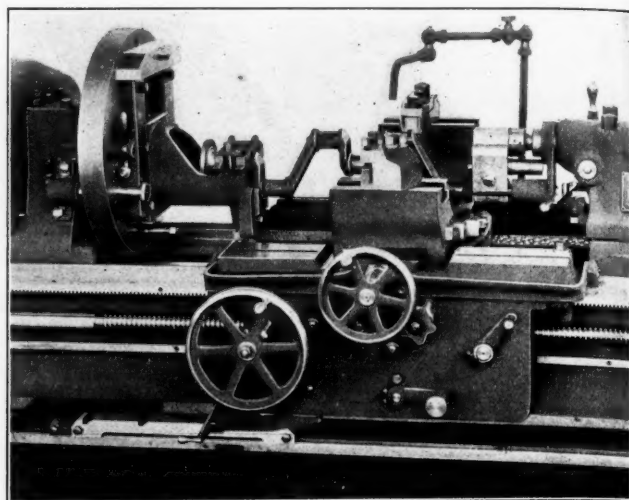

Fig. 2.   Locating the Crank-shaft in Position

taper lock bolt, as will be described. The crank itself is held fixed in the central hole of the chuck, by means of a clamp screw plug.

In setting the work in the proper position in the lathe, the face-plate is first located and held from revolving by means of the pin shown in Figs. 1 and 2, engaging a hole in the lug bolted to the side of the head-stock. The crank-shaft is then clamped in the face-plate chuck as previously described. The
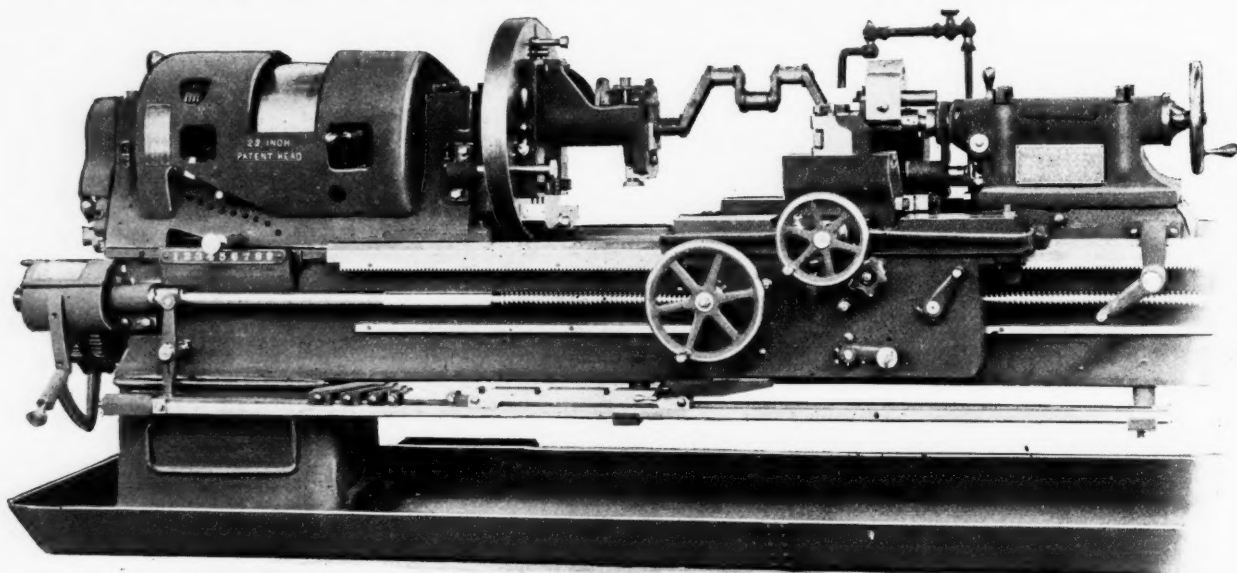

Fig. 1.   Lathe, provided with Special Chucks, Tool-posts and Stop Mechanism for Turning Crank-shafts

quickly adjusted for the changes in centers required. It affords a strong drive, and supports the crank in such a way that its tendency to spring under heavy cuts is largely overcome, thus permitting a high rate of output for the machine.

The special chuck for holding the shaft will first be described. To the face-plate are bolted adjustable ways for guiding the sliding chuck, which is provided with locating holes for a locking bolt for bringing it to the required positions on each side of the center line. This locking bolt with the lever for operating it is plainly seen in Figs. 1 and 2. The chuck is shown in its two positions in these two engravings, Fig. 1 showing it set for machining the outer throws, while Fig. 2 shows it at work on the inner throws.

Fig. 2 shows the shaft as it is first placed in the machine. The crank, whose journals have been previously turned is

tail-stock chuck is placed over the journal at the rear end, and the tail-stock is brought up to the position shown in Fig. 2, with the taper bearing pin in the tail spindle entering the bushed hole provided for it. Bolted to the front face of the tail-stock is a bracket centered accurately by means of a boss encircling the tail-stock spindle. This carries a locating pin which enters the other bearing hole in the chuck, and aligns the chuck at this end with the face-plate drive. When thus aligned, it is clamped by the screw plug arrangement. The locating pin is then withdrawn by the lever shown, leaving the chuck free to revolve on the plug arbor, after withdrawing the locating pin in the face-plate. The arbor and centering pin are made of tool steel, hardened and ground. An adjustable thrust bearing prevents the arbor from seizing in the taper thrust bearing, no matter what the end pressure.

After machining the two inner crank-pins on the center line shown in Fig. 2, the lathe is stopped, the face-plate is again located by the lock bolt in the head-stock and the tail-stock is withdrawn. The locking bolt which holds the spindle to its position on the face-plate ways, is then released and
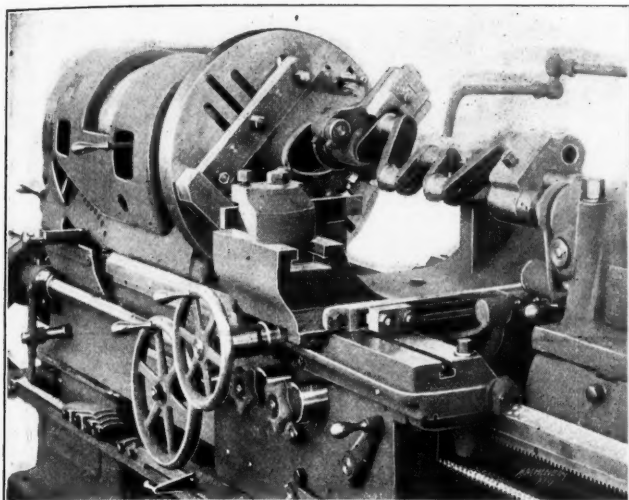

Fig. 3. The Lathe at Work

the chuck is raised to the position shown in Fig. 1, where it is located again by the bolt, so that the crank is on the new line of centers. The tail-stock is again brought up, the plug arbor entering the bearing prepared for it in the other end of the tail-stock chuck. After freeing the face-plate, the machine is then ready for turning the other two crank throws.

In addition to the work-holding device, just described, further attachments are provided for holding the proper tools, and for setting them to accurate stops for the various operations. The carriage is most plainly seen in Fig. 3. The front and rear tool blocks are cast in one piece, on a long slide mounted on the bridge of the carriage. This slide has both hand and power movement. The rear tool block carries two cutting tools which are set at the proper distances for filleting out the corner of the blank. The remainder of the stock is turned off with the front tool, leaving the pin ready for finishing on the grinder. The firm support given the tools can be seen in Fig. 3. A vertical rib extends for practically the whole length of the overhang for each tool, supporting it solidly almost out to the cutting point.

Positive stops are provided for both longitudinal and cross movements. The cross-slide stops are shown in Fig. 3, mounted to the side of the cross-slide and abutting against a heavy bracket bolted to the carriage. The construction of the longitudinal stops, most plainly shown in Fig. 1, is of unusual interest. A long bar, with a dove-tail sliding surface on its top, is mounted in bearings extending the whole length of the bed at the front of the machine. This bar, which has a limited longitudinal movement against the pressure of a spring, is connected with a lever at the head-stock end of the lathe as shown, which disengages the clutch connecting the splined lead-screw with the gear box. On the dove-tail of this bar are clamped a series of stops as shown. The long stop with four notches cut in its upper surface is the one used in this operation. These notches are spaced apart the same distance as that between the throws on the crank, thus serving to locate the carriage for the operation on each throw.

As shown in Fig. 1, the apron is provided with a projecting bracket carrying a lever. As the apron is traversed along the bed, this lever drops in the first notch it comes to. The carriage may then be fed along until the bar comes up against its solid stop at the left, when it will be found located in the position desired. By raising the lever the carriage will feed along until the lever drops into the next notch, when the carriage will be stopped for the next throw and so on.

This apparatus serves, however, not only as a positive lock, but for stopping the automatic feed as well. After locking the carriage as described for the operation of feeding down the fillet tools, the latter are moved back out of the way, the carriage is turned back, and the turning tool is brought up to begin its cut. The automatic feed is thrown in and the carriage feeds ahead until the lever drops into the notch as before, when it forces the stop bar to the left and thus throws out the feed clutch at the proper point.

The long stop with the four notches is special for this job. This form of stop motion has been found, however, very useful on regular work and provision has been made for setting it to any desired series of shoulder distances. For such work the special stop is removed and the series of five stops shown at the left are employed. These telescope over each other in such a way that they may be set for any shoulder distance, no matter how short. The carriage will feed until it comes to the first of them, when it will be stopped automatically by the means just described. The tool may then be adjusted to the diameter of the next shoulder, and the stop lever raised again, whereupon, without further adjustment, the carriage will feed until it meets the next of the stops. After again adjusting the tool for the new shoulder, the lever is raised and the feed continues to the next one—and so on. This mechanism gives a usefulness and adaptability to the stop movement of the lathe, closely approximating the more complicated provisions found on turret machinery.

CARROLL-JAMIESON QUICK-CHANGE GEAR ENGINE LATHE

The Carroll-Jamieson Machine Tool Co., Batavia, Ohio, has designed the quick-change gear lathe shown herewith. The
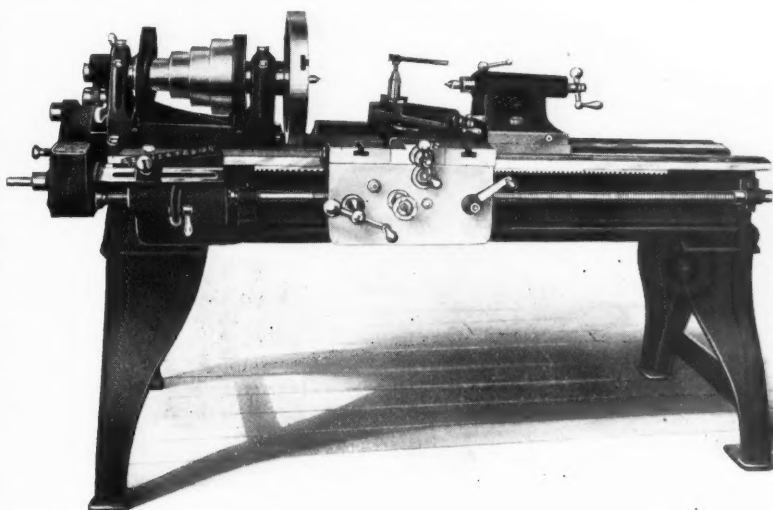

Fig. 1. Carroll-Jamieson 14-inch Engine Lathe

gear box gives 32 ratios for turning and threading without changing the gear. This range comprises all standard threads from 3 to 32, including pipe threads. The gear box,
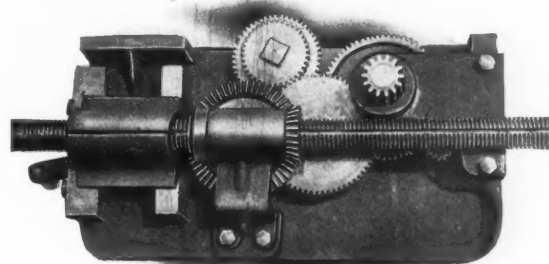

Fig. 2. Detail View of Apron Mechanism

which is of very simple construction, will be understood from an examination of Fig. 1. The shifting idler is moved longitudinally by a knob sliding in the slot of the swinging carrier shown above the gear box. The idler is swung toward

or away from cone of gears to agree with the diameter of the one it is to mesh with, by loosening the clamp handle shown in front of the gear box, and setting the frame to the required position. The changes can be made instantaneously, with one hand on the knob and one on the handle.

The improved construction of the apron is shown in Fig. 2. This is provided with friction drives, and an uncommonly long slide for the nut, provision being made for taking up wear at this point. The rack pinion has an outboard support, as shown. While nominally a 14-inch lathe, this lathe swings 14⅞ inches over the bed.

NEW TOOL-HOLDERS MADE BY THE WESTERN TOOL & MFG. CO.

The Western Tool & Mfg. Co., Springfield, Ohio, has recently added to its line a number of tool-holders of various kinds, of which examples are shown herewith. The first of these (see Fig. 1) is a turret tool-post. It is designed to give the engine lathe some of the advantages of the screw machine and turret lathe for producing duplicate work, and should be
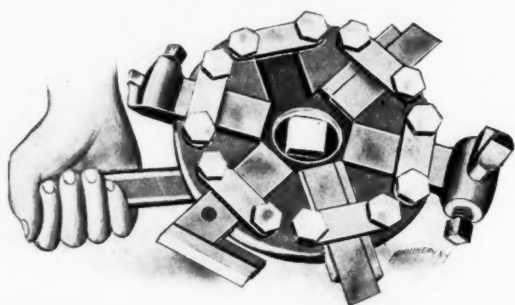
Fig. 1. A Turret Tool-holder for the Engine Lathe

found very useful for this service, particularly in shops which do not care to go to the expense of purchasing an expensive turret machine.

As may be seen, this device is mounted on an angle plate which is clamped to the tool block of the lathe in which it is to be used. The various tools are clamped by the straps and binding bolts shown, into slots in the face of a disk. This disk is mounted on a pivot, provided with a screw adjustment for centering the tools with the center line of the lathe. The clamping handle shown binds the whole structure firmly together when the cut is being taken. To change from one tool to another, it is only necessary to release the binding lever, index the disk to bring the next cutting attachment into action, and tighten it again. The separate clamping of the various tools permits each to be adjusted for the diameter of the cut to be taken.

This turret tool-post is fitted with a set of regular tool-holders furnished by the makers, including turning, threading, side, parting, and boring tools. In ordering, it is neces-

Fig. 2. A Side Tool-holder which may be used with either Right or Left-hand Blades

sary to furnish exact measurements of the tool-post slot of the lathe. The attachment is made of steel throughout, carefully hardened. It is furnished in three sizes, of which the smallest takes tool-holders with shanks ⅝ x 1¼-inch, the middle size ¾ x 1½-inch, and the large size ⅞ x 1⅝-inch.

The side tool shown in Fig. 2 is interesting in its provision for cutting either right- or left-hand in the same holder. A

dovetail groove for receiving the blade is cut on each side of the body, and the clamp may be revolved to correspond with the side in use. The tool is thus either a right- or left-hand side tool as required. A new turning tool of similar design has also been constructed, giving a choice of a right- or left-hand turning tool in the same holder.
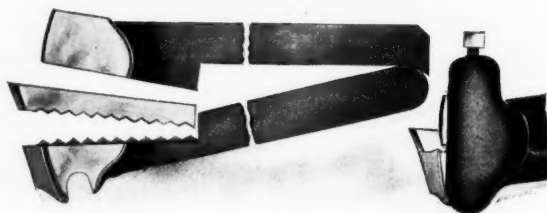

Fig. 3. A Turning Tool for Heavy Work

In Fig. 3 is shown a design of turning tool-holder intended for the heaviest work. The blade, it will be seen, is clamped in a holder which somewhat resembles a pair of tongs in its construction, having a hinge at the rear end. The clamp shown binds the two sides together with the blade between them, at a point near the cutting edge. The bottom of the blade is serrated to match corresponding serrations on the lower jaw of the holder. It is thus impossible for it to slip under the pressure of the heaviest cut.

BAUSH THREE-SPINDLE DRILL PRESS WITH MULTI-SPINDLE ATTACHMENT

The three-spindle drill shown in Fig. 1 is built by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass.
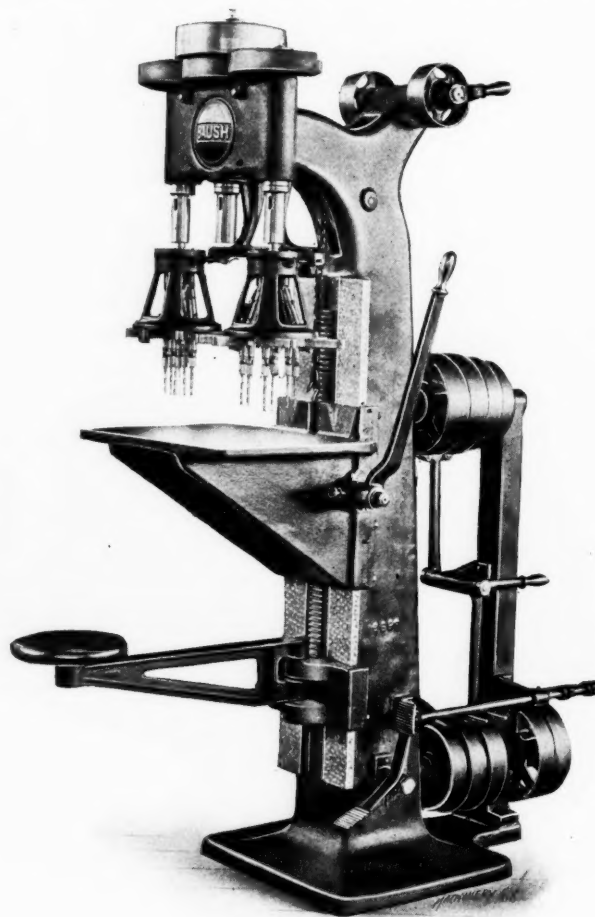

Fig. 1. Baush Three-spindle Drill

While designed particularly for use with the multiple spindle attachment shown in Fig. 2, it is well adapted to the general manufacturing work commonly performed on the multiple spindle drills of the sensitive type. It is shown with three spindles, but will be furnished with four or less, as may be required by the purchaser, although the makers have found that the three-spindle machine is the best adapted for the usual run of light drilling.

The frame is made in one piece, with ways on the face along which the stiffly designed work table is fed and adjusted. This table is counterbalanced and provided with an adjustable hand lever for feeding and an adjustable stop at the depth to be drilled. The total travel of the table is twenty-two inches. A revolving-top seat for the operator is adjustably mounted below the table.

The three-drill spindles are spaced seven inches apart and are provided with No. 3 Morse taper holes. They are connected by gearing and driven by the single vertical driving pulley shown, which is belted over the quarter turn pulleys at the rear to the upper shaft at the back of the machine. The latter is connected with the counter-shaft at the base, cone pulleys giving the machine three speeds, ranging from 272 to 377 revolutions per minute when the counter is speeded up to 320 revolutions per minute. The diameter of the tight pulley for the latter is 10 inches, for a two-inch belt. The quarter turn pulleys are mounted on an eccentric shaft for tightening the belt. The belt capacity is sufficient to drive one-inch drills.

Fig. 2 shows an attachment for the machine which is a multiple spindle drilling machine in itself. It is, in fact, a reproduction on a minute scale of the drilling head

Fig. 2. Small Multiple-spindle Attachment; may be used on Regular Drill Press

of the regular Baush multiple-spindle machine. It was designed to meet a demand for something capable of performing the same work as these large machines, but for much lighter service. As shown in Fig. 1, the attachment is very simply mounted in the drill press, it being only necessary to insert the taper shank in the spindle and hold the device from revolving by catching the steadying rod in slots provided to receive it in a bracket attached to the frame of the machine. The attachment can, of course, be used in any other make of drill press, it being a simple matter to provide means to keep the head from rotating.

This multiple drill head will be furnished with eight spindles or less, to drill anywhere within a circle of from five to eight inches diameter. The lay-out will be varied when the customer's work demands a special arrangement. The head shown in the engraving drills anywhere within a five-inch circle. It is provided with six spindles, and weighs twenty pounds. The largest drill that can be used is ¼ inch, and the maximum distance between adjacent drills is ¾ inch. The spindles are ⅝ inch in diameter. With the spindle speeds given by the machine the drill speeds are 1,000, 1,200, and 1,400 revolutions per minute respectively. A ball thrust is employed to take the pressure of the cut. A No. 3 Morse taper is provided for the driving spindle. The 5-inch head with six spindles weighs twenty pounds.

STERLING TWENTY-FOUR-INCH SINGLE WHEEL TOOL GRINDER

The Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, has just brought out the wet tool grinder illustrated, which has no pump to get out of order. Water is supplied to the wheel by a special device which acts when the wheel is running. As soon as the machine stops the water drains off the wheel, leaving it dry and in balance. The machine may be used as a dry grinder by disconnecting the belt at the left-hand side operating the device, which floods the wheel with water when in operation.

Each grinder is equipped with a 24-inch by 2-inch approved grade and grit grinding wheel; the machine can be made to accommodate a wheel three inches thick if desired. The bearings
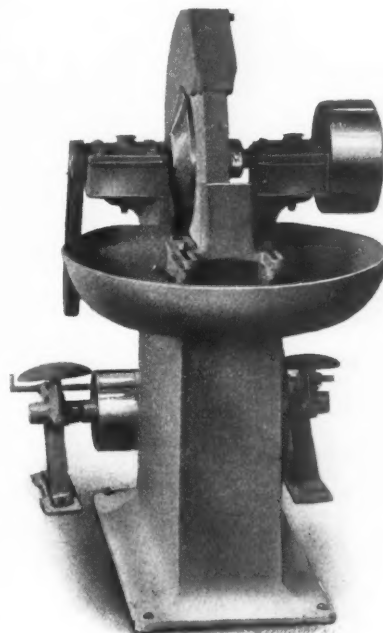

Sterling 24-inch Single-wheel Tool Grinder

are of the self-oiling type, and the following are the principal dimensions of the machine: Floor space, 30 x 45 inches; height of machine to center of arbor, 37 inches; driving pulley, 4½ x 10 inches; diameter of flanges, 12 inches; weight with counter-shaft and wheel, 900 pounds.

STEPTOE SHAPER WITH COMPACT MOTOR DRIVE

The halftone illustration shows a 16-inch shaper with an unusually compact motor drive built by the John Steptoe Shaper Co., Cincinnati, Ohio, for the United States battleship *Delaware*.
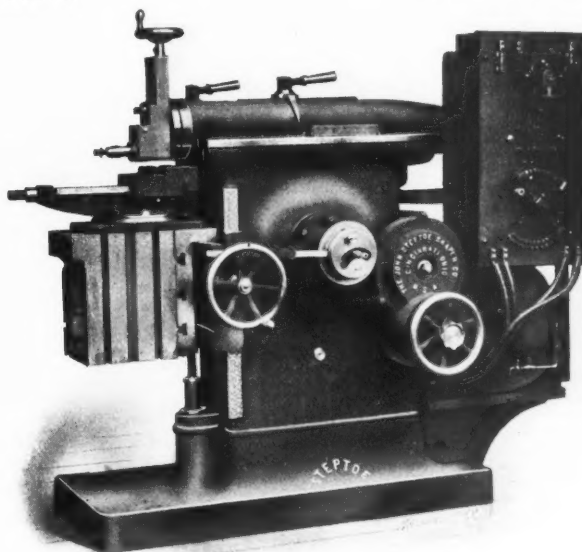
Steptoe 16-inch Shaper with Compact Motor Drive

The principal feature of the drive is the motor stand, which is set on the base of the machine, thus avoiding vibrations when the motor is running, and at the same time placing it as close to the column of the machine as is possible to get it. The arrangement of the motor is such that it takes up no more room than is actually required for the return stroke of the ram. This compact arrangement was necessary on account of the limited space available for its installation in the space assigned to it on the *Delaware*. The

controller is placed on top of the motor so that the operator is not compelled to leave his position to change the speed of the machine. The motor is made by the General Electric Co., and has a speed variation from two to one.

Another new feature of the machine is an adjustable feed rod which permits the table to be either raised or lowered by the operator without attention, the feed rod automatically adjusting itself. The device is simple, consisting of a friction box through which the feed rod of flat cold rolled stock passes. The hooks on the end of the friction box pull out the rod or shorten it as the table is raised or lowered. By means of this device the common cause of breakage of the feed mechanism is avoided, i. e., the table feeding to the end of the cross-rail and the nut on the back of the apron striking the cross-rail. The friction element then comes into action, avoiding the destruction or breakage of any part.

* * *

NEW MACHINERY AND TOOLS NOTES

POWER HAMMER: Fritz A. Schulz, 66 N. Jefferson St., Chicago, Ill. This is a light hammer of the horizontal beam type. It weighs about 500 pounds, and will strike about 300 blows per minute. The front or anvil end of the machine is mounted on a wooden block, while the rear is supported on legs.

"CRESCO" PIPE WRENCH: Crescent Forging Co., Oakmont, Pa. This wrench is made in 10, 14, 18, 24, and 36 inch sizes, taking pipe from ½ to 3⅛ inch diameter. This wrench is of very simple construction, with the gripping parts made of hardened tool steel. The thread and nut are also hardened. It is light, strong and moderate in price.

RIVET SPINNING MACHINE: Fritz A. Schulz, 66 N. Jefferson St., Chicago, Ill. This machine is arranged for rolling simultaneously the two heads of a through rivet. The work is held between the riveting spindles, which are mounted on a headstock of the lathe type. Suitable provision is made for clamping the work, and for adjusting the distance between the spindle heads.

LATHE TOOL HOLDER: Ready Tool Co., New Haven, Conn. These tool holders are made in a variety of designs adapted for turning, threading, facing, etc. They are made to take stock sizes of either carbon or high-speed steel, so that no forging of any kind is required, except for the threading tool, which has ratchet teeth cut in its rear face. They are made in a variety of designs and sizes.

QUICK ACTING VISE: Oliver Machinery Co., Grand Rapids, Mich. This vise is intended particularly for wood workers and pattern makers' use. The steel screw is provided with buttress threads, working in a solid bronze nut. The quick action is obtained by lifting the screw to free it from contact with the nut, when the front jaw may be pushed in or out as desired. When raised, it at once drops back into the nut.

CRUDE OIL FORGE: Tate, Jones & Co., Pittsburg, Pa. This is a portable forge intended to solve the difficult problem of the use of coal forges around construction work. The base of the forge furnishes the reservoir for the crude oil which is used as fuel, so that no separate receptacle is required, as when coal or coke is used. It is for this reason a much safer piece of apparatus to use, particularly in exposed and dangerous places.

WRENCH WITH SEPARATE HANDLES: New Metal Tool Steel Co., 338 Cumberland Ave., Portland, Me. This wrench is of unusual construction in that a separate handle is provided for the adjusting screw, in place of the usual knurled nut. This gives much greater power than can ordinarily be obtained, so that it can be used as a pipe wrench, or to hold round-headed bolts. By a peculiar provision in the jaws, it may be employed for cutting iron wire up to ⅛ inch diameter as well.

HYDRAULIC VALVE: Bowes-Adams Co., Monessen, Pa. This valve is designed to be used under the heaviest hydraulic pressure. By an ingenious form of construction the valve is packed against the escape of the water on bronze valve seats, instead of by cup leather packing as is usual. The continual annoyance and repairing incident to the use of leather packing is thus avoided. It is made in the three-way or four-way

type and operates for given service much easier than orthodox designs.

AUTOMATIC GRINDER FOR INSERTED TOOTH SAWS: Newton Machine Tool Works, Inc., Philadelphia, Pa. The automatic grinding device for sharpening face mills, described in the department of New Machinery and Tools in the February, 1909, issue of MACHINERY, has recently been adapted by the builders in the form of a special machine for sharpening saws, the attachment being mounted on a frame, provided with driving mechanism for rotating the saw blade. The same motor is used for driving the emery wheel and the work.

PNEUMATIC COUNTER-SHAFT: Hannifin Mfg. Co., 88-92 West Jackson Boulevard, Chicago, Ill. This counter-shaft, which provides for two speeds or forward and reverse, is operated by air, controlled by a valve at the side of the machine. The clutch surface inside of the pulley is forced into contact by a pneumatic piston, provided with cup-shaped packing. The connection with the air valve may be made by rubber tubes, or by any other form of piping, and the valve may be placed in any convenient position, considerably removed from the counter-shaft, if required.

ABRASIVE METAL CUTTER: Slack Mfg. Co., Springfield, Vt. Sales office, 15 Madison St., Hartford, Conn. On page 486 of the February, 1909, issue of MACHINERY, we described a grinding machine having thin disk wheels of alundum or other suitable abrasive, used for cutting off steels bars, piping and similar materials. This wheel is capable of severe service for this work, cutting through high-speed steel with the greatest ease. This business has been purchased by the Slack Mfg. Co. from the Colton Combination Tool Co., who were making it at the time of our previous note.

QUICK ACTING MONKEY WRENCH: Leo. M. Barrett, K. of P. Building, Indianapolis, Ind. This wrench, instead of employing a single screw as usual, makes use of a double-ended screw, one threaded right and the other threaded left hand, thus giving twice the movement to a turn of the thumb nut, ordinarily obtained. A lock nut is provided if desired to hold the adjustment permanently, though there is no more tendency for the adjustment to change than with the usual design. The wrench has a malleable hollow one-piece handle with wood grips. It is made in seven sizes, ranging from 6 to 21 inches.

SINGLE-PHASE SELF-STARTING MOTOR: Bell Electric Motor Co., Garwood, N. J. This motor is designed for single-phase service. It is arranged to start itself automatically as a direct-current motor operating on a single-phase current, the armature being wound for this purpose and provided with a commutator. High starting torque is thus obtained. When the motor has come nearly up to speed, a short-circuit mechanism automatically comes into use. This short circuits the commutator so that the motor, during its regular work, operates on the induction principle. The mechanism is exceedingly simple and, being automatic, it operates of its own accord when the current is turned on again after a stoppage from accident or intention.

TOOTH CHAMFERING ATTACHMENT: Long Arm System Co., Cleveland, Ohio. In the March, 1908, issue of MACHINERY, in the department of New Machinery and Tools, we illustrated and described an attachment for rounding the ends of the teeth of transmission gears. The makers of this attachment have recently re-arranged it to bring the cutter work spindle into a horizontal position instead of vertical as in the older design. This permits the use of a tail-stock if desired, and thus adapts the machine for work on gears located in the centers of shafts. It also permits swiveling the attachment to any desired angle, thus varying the shape of the chamfered tooth. The device is of very simple construction and works automatically until the gear is completed.

* * *

It is stated in the Engineering Record of March 20 that a vanadium steel locomotive spring in recent tests was stressed to 115,000 pounds per square inch, 23,600 times before fracture. This would indicate the great superiority of vanadium steel over other steels for purposes of this kind. It is not stated, however, when and where the tests were undertaken

OPERATIONS PERFORMED ON THE "LO-SWING" LATHE

The accompanying illustrations show a number of operations which can, to advantage, be performed on the "Lo-swing" lathe, manufactured by the Fitchburg Machine Works of Fitchburg, Mass., and described in MACHINERY, September, 1907. The feature of the lathe is that it is adapted for rapid turning of small parts, not exceeding 3½ inches in diameter. Such parts as axles, automobile steering knuckles, transmissions and cam shafts can be more economically pro-

varying lengths and depths, so that after the lathe is set up for one particular job, no time is lost by the operator in measuring lengths or calipering the work.

An interesting example of a piece which would ordinarily require considerable time for measuring is a cam shaft cut from a solid bar. Fig. 4 shows an 8-throw cam shaft, which is finished by the following method in the "Lo-swing" lathe. The first operation, as shown in Fig. 2, consists of cutting seven grooves with accurately spaced tools, so as to permit the cutting tools for removing the metal between the cams to start. The second operation, as shown in Fig. 3, consists
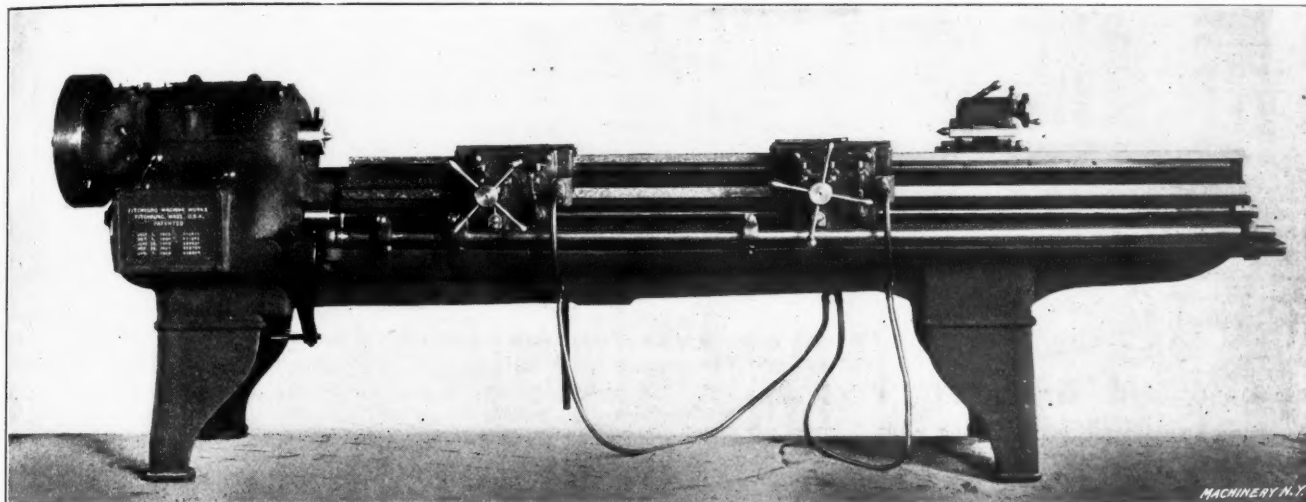
Fig. 1. "Lo-Swing" Lathe with Bed extended to Increase the Capacity of the Machine

duced on this machine than in ordinary lathes. The usual cross slide is eliminated and the adjustment of the tools is obtained by a micrometer adjusting screw bearing against the end of the tool which is itself placed in a heavy tool-

of cutting out the metal between the cams with two travels of the carriages. The tools A take the cuts over the longer distance between the cams, and the tools B the cuts over the shorter distance. The third operation, as shown in Fig. 4,
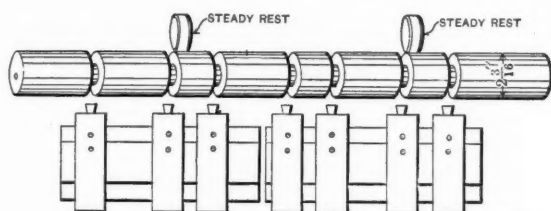

Fig. 2. First Operation in Turning Cam-shafts on the "Lo-Swing" Lathe
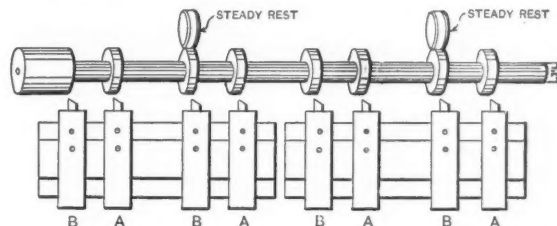

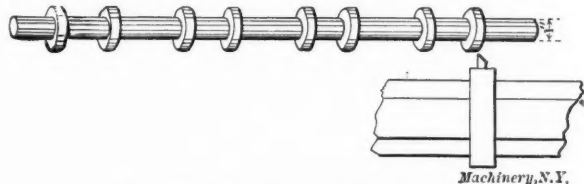Fig. 3. Second Operation: Metal between Cams Removed

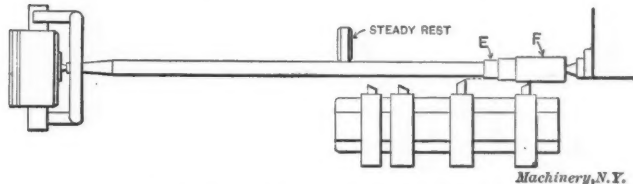Fig. 4. Third Operation: End Turned Down

Fig. 5. Second Operation: Turning E and F

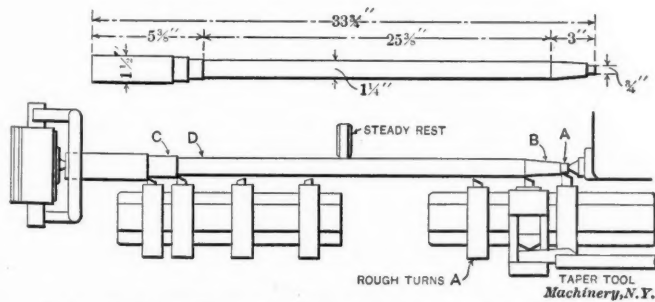Fig. 6. Shaft to be Turned and First Operation: Turning A, B, C and D

Fig. 7. Turning Steering Knuckle, First Operation: Turning A, B and C

holder. This construction reduces vibration at the cutting point and permits higher speeds and greater depth of cut.

The machine as shown in Fig. 1 with its bed extending beyond the rear leg, is provided with two carriages which are so designed that they can pass by the tail-stock. Six tool-holders are provided regularly, and by means of these, a piece having several shoulders can be finished at one travel of the carriage, instead of, as usual, machining one diameter at a time. A stop mechanism is provided to take care of the

consists of removing the metal from the end held by the dog in the second operation. By this method, the three separate operations require altogether only one hour.

Another application of the lathe is shown in Figs. 5 and 6, where the operations necessary for turning the driving shaft of an automobile are shown. The finished shaft is shown in the upper part of Fig. 6. The illustrations indicate clearly the method followed, and Fig. 6 also shows how a tapered portion is turned in conjunction with a straight part. This
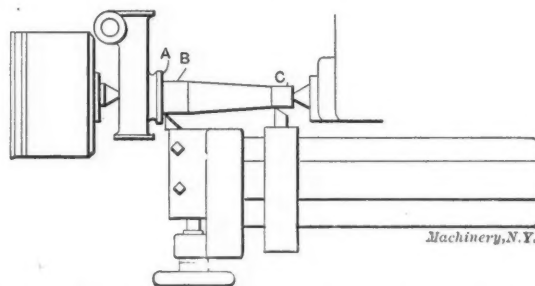
shaft can be turned in seven minutes on the "Lo-swing" lathe, whereas in an engine lathe it would require about forty minutes to finish the shaft. In the first operation the diameters C and D, Fig. 6, are turned by the tools in one carriage and the taper B and the diameter A by tne tools in the other carriage. In the second operation, Fig. 5, the diameters E and F are turned.

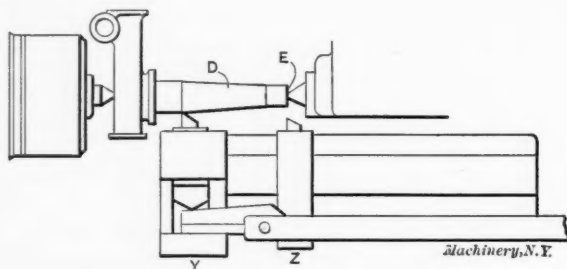
Fig. 8. Turning D with Y and Facing End with Z

Another example of work done to advantage in this machine is that of turning steering knuckles in two operations as shown in Figs. 7 and 8. In the first operation, Fig. 7, A, B and C are turned, and in the second operation, Fig. 8, the tapered part D is turned and the end E faced.

POWER REQUIRED FOR TAPPING

A series of experiments has been made by the American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, for obtaining the pulling capacity of the friction drive of the radial drills built by the company. These tests, however, are also interesting on account of the fact that they record the power required for driving pipe taps. In the accompanying table are given the results of experiments covering nominal pipe tap sizes from 2 to 8 inches, inclusive. The holes tapped were reamed with standard pipe tap reamers before tapping.

POWER REQUIRED FOR TAPPING

Nominal Size of Pipe Tap, Inches	Revolutions per Minute	Net Horse-power	Thickness of Metal, Inches
2	40	4.24	$1\frac{1}{8}$
$2\frac{1}{4}$	40	5.15	$1\frac{1}{4}$
*$2\frac{1}{2}$	38.5	9.14	$1\frac{1}{8}$
3	40	5.75	$1\frac{1}{2}$
*3	38.5	9.70	$1\frac{1}{4}$
$3\frac{1}{2}$	25.6	7.20	$1\frac{3}{4}$
4	18	6.60	2
5	18	7.70	2
6	17.8	8.80	2
8	14	7.96	$2\frac{1}{2}$

* Tapping steel casting; other tests in cast iron

The horse-power recorded was read off just before the tap was reversed. In the table, however, is given the net horse-power, deductions being made for the power required to run the drill without a load. The material tapped was cast iron, except in two instances, where steel casting was tapped. It will be seen that nearly double the power is required for tapping steel casting.

The results obtained will, of course, vary with the conditions. More power than that indicated in the table will be required if the cast iron is of a harder quality or if the taps are not properly relieved. The taps used in these experiments were of the inserted blade type, the blades being made of high-speed steel.

* * *

NEW APPRENTICE EDUCATIONAL SCHEME

A new idea in cooperative apprentice education has been developed by Mr. B. B. Quillen, of the Cincinnati Planer Co., Cincinnati, Ohio, and a committee of Cincinnati manufacturers consisting of Messrs. Fred. A. Geier of the Cincinnati Milling Machine Co., William Lodge of the Lodge & Shipley Machine Tool Co., James Hobart of the Triumph Electric Co., J. M. Manley of the National Metal Trades Association, Ernest Du Brul of Miller, Du Brul & Peters, and B. B. Quillen of the Cincinnati Planer Co., presented the plan to Superintendent Dyer of the public schools, who received it with much

enthusiasm, and presented it to the Board of Education with the recommendation to adopt same. It is expected that the school committee will establish it not later than July 1.

The plan is to send the apprentices to school one-half day each week, the employer paying the apprentice for the time he is in school. The cooperative school course will be continued throughout the term of apprenticeship contract, which in Cincinnati is four years. There are about 500 apprentices working in Cincinnati machine shops, and the manufacturers have agreed to start the course with 150 each week, which would make a class of 15 boys each half day for five days in the week.

The manufacturers feel that the loss of time of the apprentices attending school will be more than made up by their increased efficiency, and that the plan will be the means of securing many more apprentices than has been possible in the past. The course in instruction will be confined to shop mathematics, shop drawing and to other studies that will be of direct benefit to the apprentice in his daily work.

The development of the new plan will be watched with much interest. It is apparent from this move and other developments of similar nature that the need of more education for apprentices in connection with their shop training is generally recognized and the cooperative school courses devised are steps in the direction of rounding out the apprentice training more fully than is possible with the ordinary shop training common in the past. Whether it is practicable to devote only one-half day a week to this plan of educational work remains to be demonstrated.

* * *

NATIONAL MANUFACTURERS' ASSOCIATION CONVENTION

The National Manufacturers' Association held its annual convention in New York, May 17-19, the headquarters being the Waldorf-Astoria Hotel. The program included the following papers: "Mutuality and Fair Exchange in Trade Relations," by Count von Bernsdorff, the German ambassador; "The Iniquity of Anti-Injunction Legislation," by Hon. Charles E. Littlefield; "Legislation Affecting Labor Relations," by James A. Emery, general counsel of the National Council for Industrial Defense; "Law and Reason—Labor's Best Friend," by F. R. Boccock; "The Open Door and Your Opportunity," by S. D. Scudder, of the International Banking Co.; "Industrial Education and Manual Training Schools," by J. C. Monahan, superintendent of the Stuyvesant schools; "Desirable Improvements in Interstate Trade," by Thomas E. Durbin of the Erie City Iron Co.

The meeting was characterized by a bitter attack on Samuel Gompers and other leaders of organized labor in connection with the report of the committee on industrial education. It was claimed that the cause of industrial education was imperiled by the attitude of organized labor and Mr. Anthony Ittner declared that the committee could still be of service to keep the movement free from the dominance of organized labor which has its own special purpose in view and tends to sacrifice the public welfare to the supposed advantage of a class. This attack on organized labor was not unanimously supported and one member of the committee, Mr. Fred W. Sinyers, of Milwaukee, refused to sign the report on the ground that it contained too many personal opinions.

The powers of the Interstate Commerce Commission over freight rates were declared inadequate, because it gives the commission no authority to deal with a freight rate, no matter how unreasonable, until it has actually been put in force. A considerable period of time must necessarily elapse between the date of complaint and the completion of the investigation. The great variety of rates was alluded to, over 150,000,000 rate items having been filed with the Interstate Commerce Commission between July 1, 1906, and January 15, 1909.

John Kirby, Jr., Dayton, Ohio, was elected president of the association following James Van Cleave of St. Louis, who has served three terms. Mr. Kirby advocates a tariff commission which shall have the power to constantly revise the tariff in the interests of all concerned, rather than having it periodically revised by Congress in a manner detrimental to general business and favorable to certain powerful interests.

THE FALLACY OF THE BOILED SHIRT IDEA

"Look on this picture," said a professor in a school of technology, holding out a colored plate advertising a correspondence school and showing in the center of a group a smooth, well-dressed figure of a man in white collar, tie, immaculate derby hat, and trousers creased to knife-edge. On either side of the dressed figure were men in overalls holding oil cans, sledges, and other implements of the workingman. The inference was that the central figure in the boiled shirt was the directing head of the grouped men in caps and jumpers.

"But what is the truth of this picture?" said the professor. "As a matter of fact, this young fellow in the good clothes to-day is drawing a salary of $1,000 to $1,500 a year and he is holding on to that job with clinched fingers. On each side of him are men who are getting $6 a day and pay for overtime."

The point which the professor out of his experience laid emphasis upon is this old invasion of the boiled shirt into a field of training which makes the boiled shirt ideal especially intolerable. Several years ago this professor was in charge of a graduating class of young men which had shown exceptional average talent and capability. There was sharp demand for such men in the work of construction, and positions had been tendered the school graduates. But almost to a man they declined to enter this active field of construction.

"Every one of them virtually decided against the jumpers in favor of the boiled shirt. They wanted to be consulting engineers," said the professor. "I jumped all over them, but it accomplished nothing. I showed them instances in which some of the biggest establishments in Chicago had been dismissing consulting engineers until hardly one of them was left. They wanted white shirts and creased trousers and rather than take good positions as construction men they went out to look for jobs that would allow of the boiled shirt.

"And the result? Most of them to-day are employed as draftsmen in establishments which pay them only the barest living wages. The average draftsman, pursuing his white shirt ideal, is as little considered as is the counter salesman in the average dry goods store. He is making concession of salary in order to wear good clothes.

"There is no position in the field of technology to-day which has as little promise as that will-o'-the-wisp, 'consulting engineer.' A few years ago, when engineering was far more on an experimental basis, the need of the consulting engineer who had knowledge and judgment and initiative necessarily was urgent. But in these years the conditions have been changing. Standard methods have been evolved from past consultations of engineers who have attained best results. There are fewer and fewer opportunities every year for this man who is bent upon becoming a consultant in engineering.

"On the other hand, methods of construction and the active handicraft of the constructor are more than ever in demand. The builder wants somebody to build, not some one to tell him how to build. He needs the educated man in the jumpers and cap, not the fellow in the creased trousers and the colored tie. Creased trousers in the *ensemble* of an organization are the badge of the non-producer; the cap and jumper mark the producer—the man who is making dividends for the company.

"It has been remarked that the graduate of the European technical schools has a hard time in this country—and so he does. They are theoretical men, universally. They have studied to pass their examinations based upon the text book. They can't compete with the graduate of the American schools, which has carried laboratory work right along with theory. Several years ago a young fellow came over here, well equipped in theory in his particular field. He came to me, and, liking the fellow, I tried to help him. The best I could do, however, was a job for him in an establishment where he got $15 a week. He had something in him, however, and his employers saw it. They hooked him up with another young fellow who knew the practical side of things, and the two worked together in team formation. It was an entirely satisfactory arrangement. The foreigner finally was promoted a step. Still with a practical partner in his wake, he was promoted again and again. And to-day he is general manager of the plant. But virtually he got the position through shedding his boiled shirt."—*Chicago Tribune.*

THE CHAMPNEY PROCESS OF DIE SINKING

CHESTER L. LUCAS*

In this era of interchangeable manufacturing, the progress of press work for making duplicate parts has been so rapid, and so many are interested, that the description of a novel method of making dies for drop-press work may be interesting to those engaged in die making for general production as well as to those in the drop-forging industry.

Several years ago Mr. George F. Champney (now deceased) was engaged in business in Bridgeport, Conn., under the name of The Patent Steel Die Co., making dies for the forging trade and for the jewelry business, and as far as can be learned he was the originator of the "high drop" met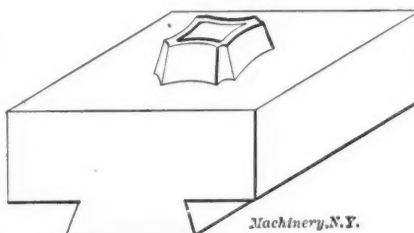hod of die sinking. This process was for a long time kept secret, and even to those who had a general idea of it, the details were not very clear. If, for example, a die for striking up a deep hollow-ware bowl was to be made, his plan was to first make a model of plaster of paris. From this

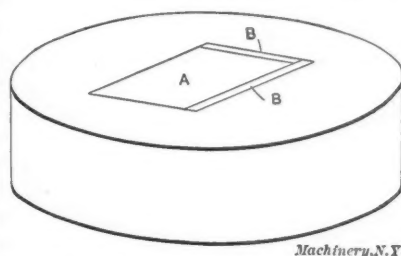Fig. 1. Casting which forms the Heated Die by being Dropped upon it

Fig. 2. Ring containing the Die Blank to be formed

model a casting, as shown in Fig. 1, was made of the finest and closest grained iron obtainable, with a large amount of metal left behind the model for strength. The sand was then cleaned from the casting without removing the hard scale, which is an important feature of this process, and it was then keyed to the hammer of the high drop. This high drop was rightly named, for although it was of the usual drop-press design, the ways are eighty feet high, the lower parts of iron and the upper of wood, faced the whole length with steel. The hammer itself is of cast iron and weighs 3,200 pounds. It is about two feet square and three feet long, and is raised by a windlass operated by hand. A pull on the rope attached to the release lever allows the huge weight to drop, and on the ways a latch is fitted to catch the hammer on the rebound, for a double blow is fatal to the die.

To the base of this great drop-press, which was necessarily very heavy, is fitted a cast iron ring (Fig. 2), which is 3 feet in diameter and 10 inches thick. The opening in the center of this ring is square and large enough to take any ordinary size of die blank. After keying the cast iron hub (or type) into the hammer of the drop and raising it to a height judged by the operator to be sufficient, the die blank *A*, which has been heated to a bright red, is placed within the square opening in the ring at the base of the press, and shims *B* placed around it so as to completely fill the space between the blank and the inside edge of the ring. The heavy hammer is then released, driving the hub with its facing of hard scale into the red-hot die blank. As the displaced steel could not go sideways on account of the shims, it had to go upwards and helped to bring the resulting impression up to shape. After being struck, the die was annealed and the scale removed by pickling; then enough was planed from the face to leave the die the proper depth, and by means of scrapers and rifflers the impression was smoothed and finished as in the ordinary methods of die sinking. Next the die was "shanked" to the press in which it was to be used, and after hardening and polishing it was ready for use.

* * *

The plant of the United States Steel Corporation at Gary, Ind., has begun to turn out steel rails—its first product.

* Address: Saugus Station, Lynn, Mass.

SPRING MEETING OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

The spring meeting of the National Machine Tool Builders' Association was held at the Plankinton House, Milwaukee, Wis., May 25-26, and was conducted by President Fred L. Eberhardt of Gould & Eberhardt, Newark, N. J., and Secretary P. E. Montanus of the Springfield Machine Tool Co., Springfield, Ohio. Forty-eight of the ninety-one concerns having membership in the association were represented by fifty-three members May 25. Following the regular business of the association, the effect of the proposed tariff on the machine tool industry at home and abroad was discussed, following which was a discussion on the extent to which machine castings should be guaranteed by foundries. This discussion was led by Mr. James N. Heald of the Heald Machine Co., Worcester, Mass., who was followed by William Lodge of the Lodge & Shipley Machine Tool Co., and P. E. Montanus. Mr. Montanus made some observations on manufacturing conditions noticed on his recent European trip, the tenor of which was that American machine tool business in Europe has reached its zenith, and that we may expect more and more strenuous competition abroad as Europeans learn and adopt American manufacturing methods. Murray Shipley of the Lodge & Shipley Machine Tool Co. made an address on "Competition," in which he discussed in some detail the various legal and moral phases of business rivalry.

On Wednesday a paper was presented by Mr. William Forsyth, "Machine Tools for Railroad Shops." In the afternoon the members visited the mammoth plant of the Allis-Chalmers Co. at West Allis, a suburb of Milwaukee. The members of the association as a whole were optimistic, and the consensus of opinion was that the business outlook is good and that the machine tool trade will boom in the Fall.

* * *

At the seventh convention of the International Railway Congress, held in Washington, D. C., in 1905, it was decided to hold the next convention in Switzerland, and it has now been officially announced that the next session will be held in Berne, July 3 to 16, 1910.

* * *

PERSONAL

Lou Hunt, timekeeper of the Fairmount Mining Machinery Co., Fairmount, W. Va., has resigned, and is succeeded by Mr. Gordon Lake.

George E. Marquette, of Kenosha, Wis., has been appointed foreman of the tool-room of the Knox Automobile Co., Springfield, Mass.

George E. Ingalls, assistant manager of the Chapman Valve Mfg. Co.'s shops at Springfield, Mass., has been appointed to a position in the main office at Boston.

U. Anderson, formerly of Fond du Lac, Wis., has been made superintendent of the Prescott Co., Menominee, Mich., following Mr. Loren Prescott, who is vice-president of the company.

Elmer E. Neal, superintendent of the Smith & Wesson Co., Springfield, Mass., revolver manufacturers, has resigned to take a similar position with the Bristol Engineering Co., Bristol, Conn.

James Dillon, of Fond du Lac, Wis., has been made machine foreman of the Prescott Co., Menominee, Mich. Mr. John Roscoe, the old floor foreman is still in place and Mr. Anton Nelson, general foreman, has resigned.

Robert Reed, chief draftsman of the Fairmount Mining Machinery Co., Fairmount, W. Va., has resigned and taken a similar position with Scotdale Foundry & Machine Co., of the same place.

Clement Booth, who for the last four years was in charge of the tool and gage department of the Remington Typewriter Co., Ilion, N. Y., is now with the Standard Roller Bearing Co., Philadelphia, Pa.

W. H. Maxwell, formerly general manager of the Angle Steel Sled Co., Kalamazoo, Mich., has resigned his position to become secretary, treasurer and manager of the Kalamazoo Steel Goods Co.

Carl S. Dow, lately publicity manager of the B. F. Sturtevant Co., and formerly in charge of instruction and textbook departments of the American Correspondence School, has joined the staff of Mr. Walter B. Snow, publicity engineer, 170 Summer St., Boston, Mass.

J. C. Jurgensen, chief engineer of the Hotel St. Regis, New York, has resigned his position to take the chair of engineering plant instruction at Columbia University next fall. A new course has been established for training students in the duties of engineers in charge of power plants.

A committee of five composed of Wilfred Lewis, Hugo Bilgram, Gaetano Lanza, Charles R. Gabriel and E. R. Fellows, was appointed April 13 by the president of the American Society of Mechanical Engineers to investigate involute gearing with a view of recommending standard tooth forms and dimensions.

Milton Thurlow, chief draftsman of the Prescott Co., Menominee, Mich., has resigned, and his position is filled by Mr. Carl Weidling, who was a former employe, before the dull times. Mr. Thurlow has obtained a position with the Berlin Machine Co., Beloit, Wis.

Claude E. Holgate, who for the past ten years has filled the position of assistant to the general manager, and has been in charge of the sales department of Gould & Eberhardt, Newark, N. J., has resigned to take charge of the automobile department of a daily paper in that city.

The author of the series "Design and Construction of Electric Overhead Cranes," now running in MACHINERY, published an article in the April 9 issue of the Engineer (London) describing a 150-ton floating crane for the Kawasaki Dockyard Co., Japan, built by Cowans, Sheldon & Co., Ltd., Carlisle, England, which was designed by him.

B. Elshoff, for twelve years assistant superintendent of the Allis-Chalmers-Bullock Co., of Cincinnati, and for the past two years superintendent of the electrical department of the Allis-Chalmers Co., of Milwaukee, recently severed his connection with the last named company. Mr. Elshoff may eventually accept a position with an eastern firm, but for the present will remain in Milwaukee.

Prof. Charles B. Richards, for the past twenty-five years head of the mechanical engineering department of the Sheffield Scientific School, Yale University, will resign his position in June. Prof. Richards was one of the founders of the American Society of Mechanical Engineers in 1881, and is the inventor of the Richards steam engine indicator.

W. A. Garrett, former president of the Sea Board Air Line Railway, and now chief executive officer, will resign his position November 1 to become vice-president of the T. H. Symington Co., Baltimore, Md. Mr. Garrett was at one time superintendent of the middle division of the Wabash R. R., and the news that he is to leave railroad service has caused considerable surprise and regret among his friends.

John J. Harman, graduate of the Mechanical Engineering College of the University of Illinois, has been made a member of the Harman Engineering Co., 120 Fredonia Ave., Peoria, Ill. Mr. Harman has been connected with the Link-Belt Co., Acme Harvester Co., United States Geological Survey, National Tube Co., etc., in various capacities.

Dwight T. Randall, member of the American Society of Mechanical Engineers, late engineer in charge of fuel tests, Technologic Branch, United States Geological Survey, has associated himself with the Arthur D. Little Laboratory of Engineering Chemistry of Boston, in charge of the Department of Fuel Engineering. Mr. Randall, who is a graduate of the University of Illinois, was formerly connected with R. W. Hunt & Co., and Westinghouse, Church, Kerr & Co., and later in charge of the Steam Engineering Laboratory of the University of Illinois, and of Steam and Boiler Tests at the St. Louis Exposition.

OBITUARIES

William Delaven, of Springfield, Mass., inventor of the Triumph voting machine and manager of the Triumph Voting Machine Co., died April 9 aged forty-six years.

Mace Moulton, a well-known consulting engineer of Springfield, Mass., died suddenly at the Ansonia Hotel, New York, April 27, aged fifty-four years.

Benjamin F. Nichols, a prominent manufacturer of Springfield, Mass., died suddenly at the Continental Hotel, New York, April 23, aged sixty years. He organized the B. F. Nichols Belting Co., Holyoke, Mass., and later capitalized the Metallic Drawing Roll Co., of which he was treasurer and manager, until he sold the stock in 1893 in order to form the England Metallic Drawing Roll Co., Manchester, England.

Ralph Scott, a young inventor of electrical appliances and author of several works on electrical engineering, died at his home in Newark, N. J., April 25, aged twenty-six years, following an operation for appendicitis. Mr. Scott was born in Bradford, England, and came to this country with his parents when young. He was the inventor of the Scott arc light and had a remarkable record as an inventor for one so young, over forty patents on various electrical contrivances having been secured by him. Just before his death, he finished at his factory at Newark, N. J., what is believed to be the largest arc light in the world for the Lackawanna Railroad terminal at Hoboken. The light is of 1,500,000 candle-power and the globe is six feet in diameter.

H. T. T. Cedergren died in Stockholm, Sweden, April 13, 1909. Mr. Cedergren was president of Stockholm's Public Telephone Co., which he founded twenty-six years ago and

which he conducted with such remarkable success that his company not only forced the Bell Telephone Co. in Stockholm, which obtained a franchise a few years earlier, out of business, but has also held its own in competition with the Swedish state telephone service. All things considered, the telephone service in Stockholm is equal or better, and the charges very much lower than elsewhere, and this record has been due in a large measure to Mr. Cedergren's exceptional managing ability. He also founded telephone companies in Moscow and Warsaw and took a prominent part in the working out of the plans for the telephone system in Mexico installed by a Swedish telephone company.

THOMAS A. WESTON

Thomas A. Weston, inventor of the differential pulley block, the multiple disk brake, the triplex chain block and other inventions, died in New York, May 3 in the seventy-eighth year of his age.

Mr. Weston, although born in England, was a thorough American, not only in the legal sense but at heart. He came to this country when quite young, and for a time was a clerk in the old hardware house of Pratt & Co., Buffalo, N. Y. He had an inventive mind and a natural aptitude for mechanics. His most widely known invention is the differential block which in later years became recognized as an addition to the so-called "mechanical powers," that is, the elementary means whereby power applied is transformed as to time and distance in its ultimate effect or result. The differential block is an adaption of the old "Chinese windlass," and is a reduction of a mechanical principle to its simplest terms, which enables a man, without other aid to lift one thousand pounds or more, and it holds the load suspended automatically at any point. The invention was patented in Great Britain and the United States, the licensees in Great Britain being Tangye Bros., Ltd., of Birmingham, and in the United States, Yale & Towne Mfg. Co., of Stamford, Conn. The invention was immediately recognized as a most valuable lifting mechanism and soon came into general use.

Mr. Weston's next most notable invention was that of the multiple disk brake, which in various forms has since been widely used in connection with machines of many kinds in which a brake resistance is needed, especially in cranes and hoists. It consists of two series of disks alternately interposed, those of one set being connected at their centers to a spindle, and those of the other set at their peripheries to an external casing. Each unit of longitudinal pressure applied to the series thus produces a frictional resistance between each pair of disks which is multiplied by the number of disks in the series, thereby making a brake mechanism of great compactness and power.

Mr. Weston's third and last important invention is the triplex chain block, manufactured by the Yale & Towne Mfg. Co., which like his original differential pulley block embodies the automatic holding of the load at all points, thereby eliminating all danger, but which in addition possesses a very high mechanical efficiency. The principle of the differential block involved a large waste of power and very low efficiency, averaging from 25 per cent to 30 per cent, whereas the triplex block attains an efficiency of nearly 80 per cent; in other words, for each 100 foot-pounds of power applied it gives back nearly 80 foot-pounds of useful work as against only about 25 foot-pounds in the case of the differential block.

Mr. Weston made numerous minor inventions, and all of the latter part of his life was occupied in the study of mechanical problems. He was a man of culture, refinement and exceptional intelligence, whose contributions to the mechanical world in the relatively minor field above indicated were of great value and importance and will have a permanent place among the notable inventions of the past half century.

* * *

COMING EVENTS

May to November, 1910.—International Exhibition of Railway and Land Transport, Buenos Ayres, Argentine Republic, commemorating the first centennial of the Argentine Independence. The officers of the exhibition are: Alberto Schneidweind, general director of Argentine Railways, president; H. H. Loveday, general manager of Argentine Railways, and Dr. H. H. Trays, local director of Central Argentine Railways, vice-presidents; Juan Pelleschi, commissioner general; Eduardo Schlatter, secretary.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch-making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—International Railway General Foremen's Association convention at Chicago, headquarters Lexington Hotel. E. C. Cook, secretary-treasurer, Royal Insurance Building, Chicago. The program comprises these papers: "Air Brake Equipment," "Coaling of Engines with Mechanical Devices," "How to Obtain the Greatest Despatch in Handling Engines Through Terminals," "Installation of Hot Water Washout and Filling System," "Best Method of getting Work through Shop with Economy and Despatch," "Most Approved Type of Ash-Pan Conforming with Requirements of the Interstate Commerce Commission," "Use of the Oxy-Acetylene Process of Welding Fire-boxes, Locomotive Sheets, Frames, and other Locomotive Work."

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, Cleveland, Ohio, secretary.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Shenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 11.—Meeting of the Internal Combustion Engineers' Association at the Sherman House, corner Clark and Randolph Sts., Chicago, to install officers for the ensuing year which were elected at the May meeting, and for the transaction of other business. Walter A. Sittig, secretary, 61 Ward St., Chicago, Ill.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 22-24.—National Gas and Gasoline Engine Trades Association convention, South Bend, Ind. Headquarters, Oliver Hotel. Albert Stritmatter, Cincinnati, Ohio, secretary.

June 24-26.—Seventeenth annual convention of the Society for the Promotion of Engineering Education at Columbia University and Pratt Institute, in New York and Brooklyn. These dates immediately precede those of the meetings of the American Institute of Electrical Engineers, the Society for Testing Materials and the American Society of Civil Engineers, and New York City is very near the geographical center of the meeting places of these three other societies. It will, therefore, be a convenient place of meeting for all who wish to attend the convention of one of the other societies. An unusually attractive program has been arranged, which will include the report of the joint committee of engineering societies on engineering education by Dugald C. Jackson, a report of the committee on technical books for libraries by Arthur H. Ford, a report of the committee on engineering degrees by William F. M. Goss, a report of the committee on entrance requirements by Robert Fletcher, besides contributed articles. In addition a special session will be devoted to the discussion of engineering mathematics by the committee of fifteen appointed at the Chicago meeting of the American Association for the Advancement of Science, which has been requested to prepare a special report for the Society for the Promotion of Engineering Education for its meeting in 1909. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

June 28.—Annual convention of the American Institute of Electrical Engineers at Frontenac, N. Y. Ralph W. Pope, secretary, 29 West 39th St., New York.

June 29.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City. General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

Oct. 18-22.—Annual convention of American Street and Interurban Railway Association at Denver, Col. Bernard V. Swenson, secretary, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue of the university for the fifty-third year.

University of Illinois, Urbana, Ill. Bulletin No. 14 containing catalogue of the school of railway engineering and administration.

University of Wisconsin, Madison, Wis. Bulletin No. 287, containing announcement of the summer session which begins June 28 and ends August 6.

Museum of Safety and Sanitation, 29 West 39th St., New York. Circular illustrating the proposed museum designed by Whitfield & King, and containing an extract from the article in the March issue of the Century by Dr. W. H. Tolman on saving lives by lessening accidents.

Museum of Safety and Sanitation, 29 West 39th St., New York. Monthly bulletin No. 1, entitled Safety, a publication issued by the Museum to promote the installation of safety devices for the protection of workmen in factories, mines, mills, and other places where there is danger from machinery or other hazards.

The Ohio Society of Mechanical, Electrical and Steam Engineers held its nineteenth meeting May 21-22 at Canton, Ohio. The following papers were presented: "Heat Insulation," L. O. Hooge; "The Interpole Motor," Prof. H. B. Dates; "Hot, Soft Water for Steam Boilers," G. H. Gibson; "On the Ethics of the Society Members," H. E. Gahr; "Continuous Melting," R. H. Probert. "Lubrication of Steam Cylinders by Grease," B. Fisher; "Recent Developments in Glower Lamps and their Application to Modern Illumination Practice," A. L. Eustice; "Some Practical Points on Power Plant Piping," Julius Roemer. David Gaehr, secretary, Schofield Building, Cleveland, Ohio.

University of Wisconsin, Madison, Wis., announces the ninth session of the Summer School for Artisans, beginning June 28 and continuing six weeks. Courses are open in steam and gas engines, electricity, machine design and mechanical drawing and other subjects. There are no entrance requirements, the purpose of the school being to offer practical instruction through lectures and laboratory work to young men in the trades. Certain advanced engineering courses are offered for those who have the requisite preparation, and a general university summer session is held during the same period. New features of the coming session are courses in public utility testing and accounting. Further information may be obtained from F. E. Turneaure, Dean of the College of Engineering, University of Wisconsin, Madison, Wis.

The Air Brake Association held its sixteenth annual convention at Richmond, Va., May 11-14, at which the following papers were presented: "Pipes and Pipe Fittings for Locomotives and Cars," by J. R. Alexander; "Air Brake Instruction," by Thomas Clegg; "Yard Air Brake Test Plants and Air Brake Repairs," by F. Von Bergen; "Higher Braking Power," by J. W. Kiehn; "How Can the Road Foreman of Engines Render the Most Effective Assistance to the Air Brake Service?" by John Talty; "Handling Passenger and Freight Trains with 'ET' Equipment," by H. A. Flynn; "The Engine House Inspection Repairs and Maintenance of Air Brakes," by W. D. Seeley; "The Best Arrangement of Air Pump and Main Reservoir Capacity for 100-Car Train Service," by J. P. Langan. The secretary of the association is F. M. Nellis, 53 State St., Boston, Mass.

Postal Progress League, 361 Broadway, New York, is an association formed to effect a much-needed change in the United States postal service rates. It advocates a reduction of the general merchandise rates from 16 cents per pound to 8 cents per pound, which is the old rate of 1874; in the rural service, a common tariff on all local mail matter of one cent on parcels up to 1/24 cubic foot (6 x 12 x 24 inches); five cents on larger parcels up to 1/2 cubic foot (6 x 12 x 12

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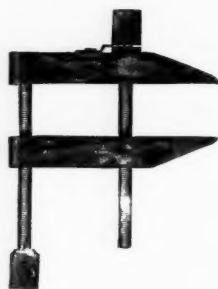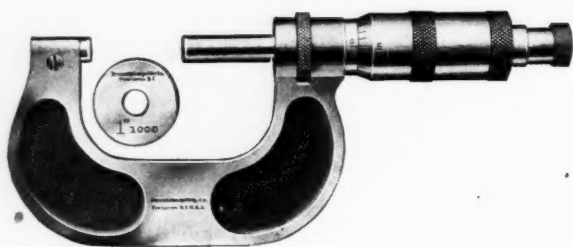
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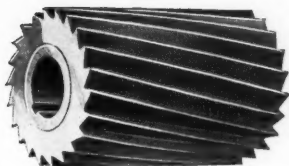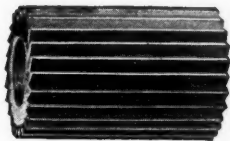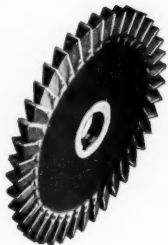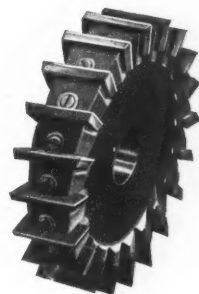
inches); ten cents on still larger parcels up to one cubic foot (6 x 12 x 24 inches). The space rate should be limited to one cubic foot, length six feet, weight twenty-five pounds. The league advocates these rates as effective means of checking the extortions of the express companies, and making the postal service self-supporting by adding millions to its revenues.

AMERICAN FOUNDRYMEN'S ASSOCIATION AND AMERICAN BRASS FOUNDERS' ASSOCIATION held a joint convention at Cincinnati, Ohio, May 18-20. A fine line of foundry machinery and foundry appliances were exhibited. The following papers were presented: "The Manufacture of Brass Ingot; Its Uses and Advantages," by W. M. Corse; "The Use of Waste Heat," by F. W. Reidenbach; "The Patent Situation in the U. S. Respecting Alloys," by C. H. Clamer; "The Cost of Steel Melting in Foundries," by Dr. Bradley Stoughton; "The Side Blow Converter for Steel Castings and Its Operation," by J. S. Whitehouse; "Open Hearth Methods for Steel Castings," by W. M. Carr; "Notes on Air Furnace Construction for Malleable Castings," by W. H. Kane. "The Use of Pulverized Coal for Foundry Purposes," by Richard K. Meade; "Machine Molding vs. Hand Molding," by George Muntz; "Pattern Shop Equipment," by A. M. Spencer; "The Heart of the Foundry as Seen by the Foundry Engineer," by D. S. Hawkins; "Cores and Core Making," by F. K. Cheney; "Continuous Melting in the Foundry of the Westinghouse Air Brake Co.," by S. D. Sleeth; "Continuous Melting," by R. H. Probert; "The Permanent Mold," by Edgar A. Custer; "The Practical Value of Chemical Standards for Iron Castings," by Dr. J. J. Porter; "Pyrometry in the Annealing Room," by S. H. Stupakoff; "General Principles of Operation of Industrial Pyrometers," by C. H. Wilson. "Notes on Brass Melting," by Charles T. Bragg; "Melting of Brass Turnings in the Oil Furnace," by E. H. McVeen; "Electrolytic Assay of Copper," by George L. Heath; "The Tensile Strength of Zinc-Aluminum Alloys," by W. D. Bancroft; "System of Distributing Waste Losses in Raw Materials to the Cost of the Finished Product," by L. W. Olsen; "A Comprehensive Foundry Production Tally," by C. E. Knoeppel; "Foundry Costs," by B. C. Franklin; "Modern Cupola Practice," by J. C. Knoeppel; "Notes on Steel Scrap in the Cupola," by C. R. McGahey. Richard Moldenke, Watchung, N. J., secretary-treasurer of the American Foundrymen's Association; William Corse, secretary, American Brass Founders' Association.

NEW BOOKS AND PAMPHLETS

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1907.　789 pages, 6 x 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

TEST OF REINFORCED CONCRETE BEAMS : RESISTANCE TO WEB STRESSES. By Arthur N. Talbot. 86 pages, 6 x 9 inches Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This pamphlet on tests of reinforced concrete is No. 29 of the series 1907-1908. It supplies data on resistance to web stresses which has not been as thoroughly investigated as has tensile resistance of the reinforcement and compressive resistance of the concrete. The pamphlet tabulates the results of a large number of tests.

TABLES OF THE PROPERTIES OF STEAM AND OTHER VAPORS. By Cecil H. Peabody. 133 pages, 6 x 9 inches. Published by John Wiley & Sons, New York. Price $1.

This well-known work which was published in 1888 has passed into the 8th edition and has been rewritten and is offered to the public by the author with confidence that the new methods of redetermining the properties of steam are such that the tables may be expected to have permanence. The temperature-entropy table gives the solution both for saturated and for superheated steam. The tables are excellent examples of fine typography.

RESULTS OF PURCHASING COAL UNDER GOVERNMENT SPECIFICATIONS. By John Shober Burrows. 44 pages, 6 x 9 inches. Published by the United States Geological Survey, Washington, D. C.

The pamphlet reviews the results of purchasing coal under government specifications, and is accompanied by a paper by Dwight T. Randall on burning the small sizes of anthracite for heat and power purposes. The paper will be found of general interest to power plant managers and others concerned with the economical production of power.

SIGNIFICANCE OF DRAFTS IN STEAM-BOILER PRACTICE. By Walter T. Ray and Henry Kreisinger. 61 pages, 6 x 9 inches. Published by the United States Geological Survey, Washington, D. C.

The experiments thus far made seem to indicate that it is possible to double or treble the capacity of a boiler without making radical changes in the furnaces and boilers. The experiments are of great interest to power plant managers, especially those troubled by insufficient capacity and the apparent necessity of increasing the capacity by adding new equipment.

INTERNAL COMBUSTION ENGINES. By William M. Hogle. 256 pages, 6 x 9 inches. 106 illustrations and diagrams. Published by the McGraw Publishing Co., New York. Price $3.

The aim of the author in preparing this work was to confine the treatment to the practical and applied phases of the subject, eliminating so far as practical the involved thermodynamic mathematical formulas found in other works on the gas engine. The general scope of the work is indicated by the following chapter headings: The Beau de Rochas Cycle ; The Clerk Cycle ; The Diesel Motor ; Comparison of the Cycles ; Practical Operation ; Care of Engine (troubles and remedies) ; Starting Devices ; Carbureters, Vaporizers and Injectors ; Producers ; Fuels and Combustion ; Compression ; The Indicator Card ; The Cylinder ; The Fly-Wheel ; The Frame ; Engine Foundations ; The General Dimensions ; The Cam Mechanism ; The Valves and Ports ; Crank-Shaft and Reciprocating Parts ; Governing Devices ; Ignition ; Engine Testing ; and Report of Tests.

AUTOMATIC SCREW MACHINES AND THEIR TOOLS. By C. L. Goodrich and F. A. Stanley. 255 pages, 6 x 9 inches. 284 figure numbers. Published by the Hill Publishing Co., New York. Price $2.

The wide development of the automatic screw machine makes an authoritative work on screw machine practice most welcome. The work covers the leading machines, comprising the Pratt & Whitney, Brown & Sharpe, Cleveland, Gridley, Alfred Herbert, Spencer, Acme, Potter & Johnston, and Prentice machines of the single-spindle and multiple-spindle types, illustrating and describing their constructive features. The second section treats of points on setting up and operating, speeds and feeds, spring collets and feed chucks, box tools and other external cutting appliances, drills, counterbores and other internal cutting tools, screw machine taps and dies, forming tools and methods of making them, knurling tools and their applications, why chips cling to screw machine tools, etc. The work is printed on heavy coated paper and the general typographical appearance is excellent.

HARPER'S MACHINERY BOOK FOR BOYS. By Joseph H. Adams. 372 pages, 5½ x 7⅞ inches. Illustrated. Published by Harper & Bros., New York. Price, $1.75.

The aim of the work is to instruct boys in the principles of machinery and the use of tools and to impress that knowledge by giving plans by which water wheels of the over-shot, under-shot and Pelton types, steam turbines, steam engines and boilers, windmills and turning lathes, pumps, force pumps, siphons, power transmission by belts, shafts and gearing, motor boats, jig saws, and a large variety of other machines of a simple nature that can be built of wood, and wood and metal in combination with the tools and supplies that are within the

reach of enterprising boys having plenty of leisure and pocket money. The scope of the book is indicated by the following chapter headings : Principles of Simple Mechanics ; Mechanic's Tools ; Power ; Power Transmission ; Water Power ; Wind Power ; Steam Power ; Electric Power ; Hydraulics ; Machinery ; Metal-Working Machinery ; Wood-Working Machinery ; Stone and Marble Working Machinery ; Concrete Construction and Machinery ; Metal Casting and Foundry Work ; Forging, Welding and Brazing ; Miscellaneous Machines and Apparatus ; Automobiles ; Motor Boats ; The Stationary Gas Engine ; Shop Hints ; Formulas ; Tables, Gages and Measures ; A Dictionary of Mechanical Terms. The book is one that will be prized by the average boy of a mechanical bent of mind. Most of the apparatus illustrated no doubt may be constructed from the sketches with fair satisfaction. Some crudity of expression is apparent, particularly in description of gas engines and metal-working tools. The fly-wheel of a gas engine is described as keeping up the motion from working stroke to working stroke "through its stored up centrifugal force." A planer is called a "bed planer," and its platen a "traveler." A knee-type milling machine is a "gear cutter and shaper," and the "bed travels carrying the work back and forth against the tool." The author evidently did not fully understand the principle of action of the milling machine. While slips of this nature are not important, in a sense, it is unfortunate that a book of instruction for the young should contain errors that tend to prejudice those who know against it. The illustrations are free-hand ink sketches and halftones. The latter are made with a coarse screen, the result being that many of the details are lost or obscured. The dictionary of mechanical terms is a valuable feature and well prepared. The book, as a whole, is one that can be commended to those desiring to place a work of this character in the hands of their boys.

CATALOGUES AND CIRCULARS

S. F. BOWSER & CO., LTD., Toronto, Canada. Circular of self-measuring oil pumps for shops, factories, round-houses, garages, etc.

C. W. HUNT CO., 45 Broadway, New York. Catalogue No. 091 of coal and ore handling machinery.

INGERSOLL-RAND CO., 11 Broadway, New York. Circular No. 4010 of telescope feed hammer rock drills.

INGERSOLL-RAND CO., 11 Broadway, New York. Circular No. 3001 of air and gas compressors.

AMERICAN ELECTRIC FUSE CO., Muskegon, Mich. Catalogue of Allen-Bradley rheostats and electric controlling apparatus.

D. VAN NOSTRAND CO., 25 Murray St., New York. Catalogue of scientific books recently published.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 112 of exhaust fans driven by electric motors, direct connected.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 113 of large direct current motors for direct connection.

HORACE L. WINSLOW CO., Old Colony Building, Chicago, Ill. Catalogue of Clark blow-off system for locomotives and other steam boilers.

WARREN-WEBSTER CO., Camden, N. J. Circular announcement of the 80-page general catalogue of Webster specialties.

DEAN BROS. STEAM PUMP WORKS, Indianapolis, Ind. Catalogue No. 77 of steam pumps.

CHAPMAN BALL BEARING CO., Boston, Mass. Circular of Chapman ball bearings showing applications to loose pulleys and line-shaft bearings.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheets Nos. 35 and 36, illustrating worms and worm-wheels mounted with Hess-Bright ball bearings.

NORTHWESTERN EXPANDED METAL CO., Old Colony Building, Chicago, Ill. Booklet of expanded metal manufacture giving valuable data on the strength of reinforced concrete.

E. G. SMITH CO., Columbia, Pa. Circular listing "Which Way" levels and Smith beam calipers sold at special prices to clean out stock.

BROWN SPECIALTY MACHINERY CO., Chicago, Ill. Catalogue of the Hammer core machine for making a great variety of cores with rapidity and cheapness.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 66 on smoke box superheater and feed water heaters, by John W. Converse and Lawford H. Fry, reprinted from the Railroad Age Gazette.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Circular advertising "Peerless" high-speed reamers, "Perfect" double tang sockets, and "Paradox" adjustable reamers.

S. W. CARD MFG. CO., Mansfield, Mass. Booklet entitled "The Passing of the V-Thread" (see MACHINERY, March, 1909), giving the reasons why the sharp V-thread should be abandoned in favor of the U. S. standard thread and pitches.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet of graphite products which is a pocket edition of the general catalogue of the products of the company, listing crucibles, flake graphite, machine grease, lubricating graphite, etc.

SHEPARD ELECTRIC CRANE & HOIST CO., 50 Church St., New York. Bulletin No. 502 of the Shepard electric hoists which are built in over four hundred types and sizes with a capacity from 500 pounds to 20 tons.

SKINNER CHUCK CO., New Britain, Conn. Set of four blotter advertising cards illustrating the Skinner planer chuck, combination lathe chuck, 1904 pattern individual lathe chuck, and geared pattern drill chuck.

HANNIFIN MFG. CO., Chicago, Ill. Catalogue of Aero chucks, friction chucks, cost-reducing tools, air counter-shafts, gate valve seating machines, etc. This company is the successor of the Manufacturers' Equipment Co.

NAPPANEE IRON WORKS, Nappanee, Ind. Circular of the Nappanee portable cylinder boring bar for general work, which is made in three sizes. This boring bar was illustrated and described in the May number of MACHINERY.

PHILADELPHIA GEAR WORKS, INC., 1120-1122 Vine St., Philadelphia, Pa. Match scratcher advertising cut gears and card deprecating the policy of waiting until business improves before placing orders for goods.

W. W. OLIVER MACHINE CO., Buffalo, N. Y. Catalogue No. 17 of rolling mills, polishing machines, drop presses, draw benches, drills, foot-power lathes, bench shears, rod cutters, and other light machinery for the working of metal.

PNEUMATIC NUT MACHINERY CO., INC., 224 High Ave., Cleveland, Ohio. Circular illustrating a nut tapping machine having a turret with six taps and six facing tools and pneumatic feed. The nuts are fed, tapped and removed by a controlled automatic system.

WEBSTER & PERKS TOOL CO., Springfield, Ohio. Catalogue of grinding and polishing machinery, comprising : Bench grinders, floor grinders, edge grinders, buffing and polishing lathes, etc. The catalogue illustrates automatic oiling devices applied to these grinders for insuring copious supply of lubricant to the bearings.

NORTHWESTERN EXPANDED METAL CO., 930-950 Old Colony Building, Chicago, Ill. Booklet of beam and column data compiled by Ernest McCullough, chief engineer of the company. The booklet contains a fund of valuable data on beams and columns, and advertises the expanded metal manufactured by the company.

WEBSTER TOOL & MFG. CO., Springfield, Ohio. Catalogue of tool holders, expanding mandrels, portable stands, surfacing files, turret

Cincinnati

High Power Miller
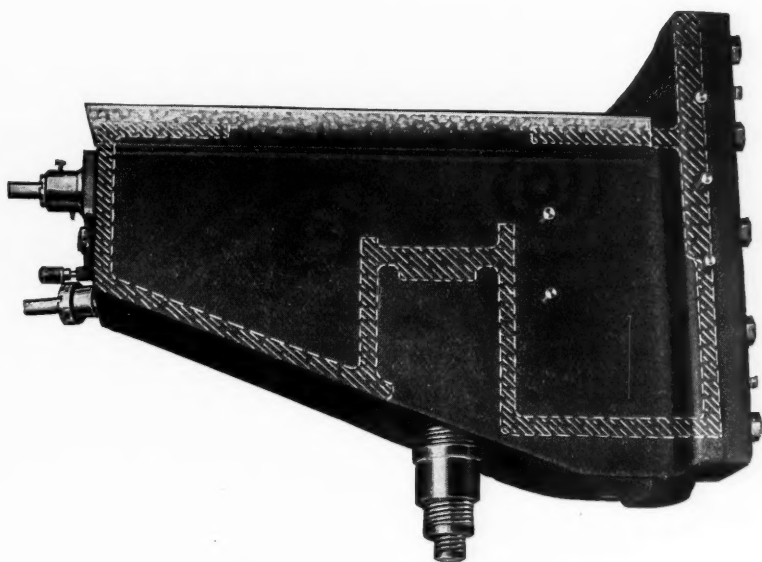
Rigidity

The knee of a Miller is subjected principally to twisting strains due to the pressure of the cutter against the work, tending to overturn the table and saddle.

Cincinnati High Power Miller Knees are designed to resist these twisting strains. The cuts show the webbing. They are reinforced boxes, and a box will resist twisting better than any other rectangular structure.

Prove this to yourself.

Take a light box, complete with lid fastened down and note its torsional stiffness compared with a box of the same size that has no bottom and only one end made of boards twice as thick.

The complete box will win.

This is the principle on which our machines are designed throughout.

The Cincinnati Milling Machine Company
Cincinnati, Ohio, U. S. A.

tool-posts, bench legs, C-clamps, lathe dogs, friction clutches, adjustable shell reamers, grinders, quick-change drill chucks and collets, shapers, engine lathes, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins Nos. 46 and 59, describing Type I ammeters, voltmeters, and wattmeters for alternating current circuits. The indications of the pointer are rendered "dead beat" and the scale extends through an arc of 300 degrees, and is practically uniform throughout. The instruments are so constructed as to be uninfluenced by stray fields.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet illustrating features of the original constant-speed drive milling machine. This attractive booklet illustrates the Brown & Sharpe constant speed mechanism, the feed works and other details. It concludes with tables of general dimensions of universal milling machines Nos. 2-A, 2-A heavy, 3-A heavy, and 4-A heavy.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1502, containing valuable information on alternating current distribution, covering transformers, lightning arresters, insulators, cross-arms, etc. The circular contains fifty-two pages of information of value to central station managers and others concerned with the distribution of power by alternating current systems.

S. OBERMAYER CO., Cincinnati, Ohio. Leaflet endorsing the movement to increase the available daylight hours during the summer, which was initiated in England. The leaflet advocates advancing the standard time in the United States two hours beginning May 1 and continuing until October 1. The two additional hours given in the hot season are the coolest hours of the day and are best for labor and exercise.

ARMSTRONG BROS. TOOL CO., 113 N. Francisco Ave., Chicago, Ill. Circular of the Armstrong automatic drill drift for loosening taper tang twist drills in their sockets. This drill drift requires no hammer, the handle acting as a hammer being slidably mounted on the drift and retracted by a coil spring. This tool was formerly made by the Automatic Drill Drift Co., and was illustrated in the July, 1908, number of MACHINERY.

NILES-BEMENT-POND CO., 111 Broadway, New York. *Progress Reporter* No. 19 illustrating the Niles extra heavy driving wheel chucking lathe which has a capacity of eight pairs of driving wheels in ten hours, and the Niles standard driving wheel lathe having a capacity of five to six pairs of driving wheels in ten hours. The catalogue also illustrates the Pond car wheel lathe having a capacity under ordinary conditions of twelve to fourteen pairs of steel-tired car wheels in ten hours.

T. R. ALMOND MFG. CO., Ashburnham, Mass. Quotation from the decision of the United States Circuit Court of Eastern District of New York rendered March 27, 1909, in the litigation of Jacobs Mfg. Co. vs. T. R. Almond Mfg. Co., in which it was decided that the use of a chuck wrench carrying a pinion intended to engage teeth cut in the scroll ring of the chuck by the defendant company is not an infringement. The Jacobs patent is declared invalid.

WESTON ELECTRICAL INSTRUMENT CO., Newark, N. J. Post-card advertising Weston electrical instruments in a novel manner. The card ostensibly is that of the "Weston Correspondence Schools," and in a few words tells how expensive and unsatisfactory educational experience with unsatisfactory electric instruments can be avoided by purchasing the Weston instruments in which the customer gets the benefit of the best work that experience and brains have been able to produce.

BROWNING ENGINEERING CO., Cleveland, Ohio. Bulletins Nos. 31, 34, and 35 illustrating the Browning lifting magnet for handling castings, scrap metals, structural shapes, etc.: the Browning automatic buckets for handling ore, coal, sand and other materials, and the Browning locomotive crane of the revolving type, operated by steam or electricity, designed for general railway work, such as coaling locomotives, light wrecking work, and for use in industrial plants, stone and brick yards, sand and gravel pits, etc.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Catalogue No. 7 of milling machines of the planer type and knee type. The company has had experience for over twenty-two years on this line of milling machines and has been a consistent advocate of the use of the milling machine for machine operations commonly done on the planer. The line is comprehensive, extending from 20 inches to 10 feet, having from one to four or more heads, arranged according to the needs of the customer. The catalogue also lists inserted tooth milling cutters and illustrates a variety of manufacturing work which these machines are doing in various manufacturing plants.

GRONKVIST DRILL CHUCK CO., 18 Morris St., Jersey City, N. J. Circular of the Gronkvist drill chuck, made in five sizes, having a capacity from 1/32 to ¾ inch inclusive. In this chuck the ordinary sharp steel jaws are replaced by three hardened rolls which engage the drill and hold it by pressure. The greater the resistance, the tighter the drill is held. No wrench is used, and drills may be released, gripped, tightened and centered with the machine running, it being unnecessary to stop the machine to change drills within the limits of the chuck.

HUDSON-FULTON CELEBRATION COMMISSION, Tribune Bldg., New York. Booklet giving a brief history of Henry Hudson and Robert Fulton with suggestions designed to aid the holding of general commemorative exercises during the Hudson-Fulton celebration, September 25 to October 9. The booklet contains a list of the members of the commission and the general plan of the celebration. The commission is raising a fund of $500,000 to cover the expenses, and contributions are solicited.

WAGNER ELECTRIC MFG. CO., St. Louis, Mo. Bulletins Nos. 82 and 83 on polyphase motors and single-phase motors. The Wagner single-phase motor is self-starting, working by repulsion at the start and induction when full speed is attained. A centrifugal governor draws the brushes out of contact with the commutator when full speed is attained, and it then operates the same as the ordinary squirrel cage form of motor. The circular illustrates the application of the motor to vacuum pumps, vacuum cleaning machines, deep well pumps, air compressors, elevators, drill presses. The motor requires no starting box, an ordinary two-pole switch being all that is required for starting and stopping.

KINKEAD MFG. CO., 7 Water St., Boston, Mass. Circular illustrating the Kinkead apparatus for aligning and leveling shafting, comprising a special architect's level and fixed and portable targets, also of special design. The portable target is supported by the shafting, having jaws that grip the shafting and hold the target center at the same distance from the center of the shafting even if it varies in diameter. Some surprising results have been obtained by aligning long lines of shafting in factories by the Kinkead method; in one case the friction load was reduced from 73 to 20 per cent. The time required by this apparatus is much reduced as compared with the common method. In some large textile mills in which the power consumption is an important factor in cost, the advent of this apparatus has enabled all the shafting to be gone over once a month and all hangers kept constantly adjusted in perfect alignment.

GRONKVIST DRILL CHUCK CO., 18 Morris St., Jersey City, N. J. Catalogue of the Johansson combination gages. The Johansson gages are made in Sweden, and are doubtless the most accurate production in existence. They have practically absolutely flat surfaces and parallel sides. The steel of these gages is hardened and treated so that molecular changes are eliminated. The catalogue illustrates some of the combinations that can be made with these gages. With a No. 1 set, consisting of 81 blocks, the sizes vary by 0.0001 inch

and a gage ten inches long can be built up, which means that the set consists of not less than 100,000 different gage sizes for internal use. By adding the standard plug gage and a holder and the same number of plugs and snap gages are obtainable. The number of combinations thus made possible are not less than 300,000. The gage is warranted accurate within one hundred-thousandth part of an inch per inch.

MANUFACTURERS NOTES.

CINCINNATI PLANER CO., Cincinnati, O., recently broke ground for an addition that will double the capacity of its plant at Oakley.

MASSEY VISE CO., Chicago, Ill., has removed to its new building, 208-210 Michigan St., where improved facilities have been provided for manufacturing the Massey punch, planer and milling machine vises.

ANGLE STEEL SLED CO., Kalamazoo, Mich, manufacturer of steel sleds, chairs, stools, etc., has removed its general office to Otsego, Mich. The manufacturing plant will remain in Kalamazoo. Mr. C. E. Pipp is general manager.

INDEPENDENT PNEUMATIC TOOL CO. has removed its general offices from the First National Bank Building, Chicago, Ill., to its own new "Thor" building at 1307 Michigan Ave., where larger space and better facilities are provided for taking care of the company's growing business.

NATIONAL SCALE CO., formerly of Beaver Falls, Pa., manufacturers of computing scales, has been reorganized and has moved its equipment from Beaver Falls to Chicopee Falls, Mass. The capitalization of the company is $125,000, $50,000 of which was raised at Chicopee to secure the industry.

ING. ERCOLE VAGHI, formerly Vaghi, Accornero & Co., Milan, Italy, has been reorganized with increased capital and a larger number of salesmen to take care of their increasing business. The Niles-Bement-Pond Co. has recently placed the agency for the Pratt & Whitney product with this firm.

PRESCOTT CO., Menominee, Mich., saw-mill builder, under its new management has introduced a comprehensive cost system, and a number of new machine tools have been added to the shop equipment, including a large Niles crank shaper, a 42-inch Niles boring mill, Pawling & Harnischfeger drill, several lathes, etc.

KALAMAZOO STEEL GOODS CO., of which W. H. Maxwell, formerly general manager of the Angle Steel Sled Co., is secretary-treasurer and manager, will manufacture steel furniture, chairs, and stools, and do electrical welding to order, also all kinds of special work in steel shapes.

SCREW CUTTING COMPANY OF AMERICA, Philadelphia, Pa., has removed from 150 Berkley St., Wayne Junction, Philadelphia, to its new factory on the corner of 17th St. and Sedgley Ave., near the North Philadelphia station of the Pennsylvania Railroad. The new plant will be in operation about June 1.

WILLIAM J. SMITH CO., New Haven, Conn., has appointed the well-known engineering firm of Vickers, Sons & Maxim, Ltd., 32 Victoria St., London, S. W., England, as sole agents for the sale of the Smith "one-lock" adjustable reamers in Great Britain, France, Germany, Belgium and Austria.

ARTHUR D. LITTLE, INC., 93 Broad St., Boston, Mass., announces that the business of the laboratory established in 1886 has been incorporated under the above name in order that the facilities of the laboratory may be further extended. The company is prepared through its large staff of specialists, to undertake any work involving the application of chemistry to industry.

B. C. AMES, Waltham, Mass., has moved into his new reinforced concrete factory, which has two stories and basement. The floors, walls, roof and stairs are all of concrete, the lower floor being supported by concrete pillars in the basement. The two main rooms have a clear floor space about 70 feet long each. The upper floor will be used for the manufacture of fine measuring gages, while the lower floor will be given over to the manufacture of bench lathes and general machine work.

SLACK MFG. CO., Springfield, Vt., is a partnership recently formed with W. W. Slack, president (Gilman & Son, Inc., Springfield, Vt.); H. K. Parkman, secretary (Gilman & Son, Inc., Springfield, Vt.); and G. C. Parker, sales manager (William J. Smith Co., New Haven, Conn.), for the manufacture and sale of an abrasive metal cutter. All the parties will retain their present positions with their respective companies. The sales office of the company will be at 15 Madison St., Hartford, Conn.

VALLEY CITY MACHINE WORKS, Grand Rapids, Mich., has purchased a plot of land thirty-three feet wide adjoining its factory and will build an addition 42 feet by 66 feet to provide for its increasing business in the manufacture of wood-working and grinding machinery and water motors for washing machines. This motor has been on the market about one year and has made "a hit" with the washing machine manufacturers because of its simple, compact construction and power.
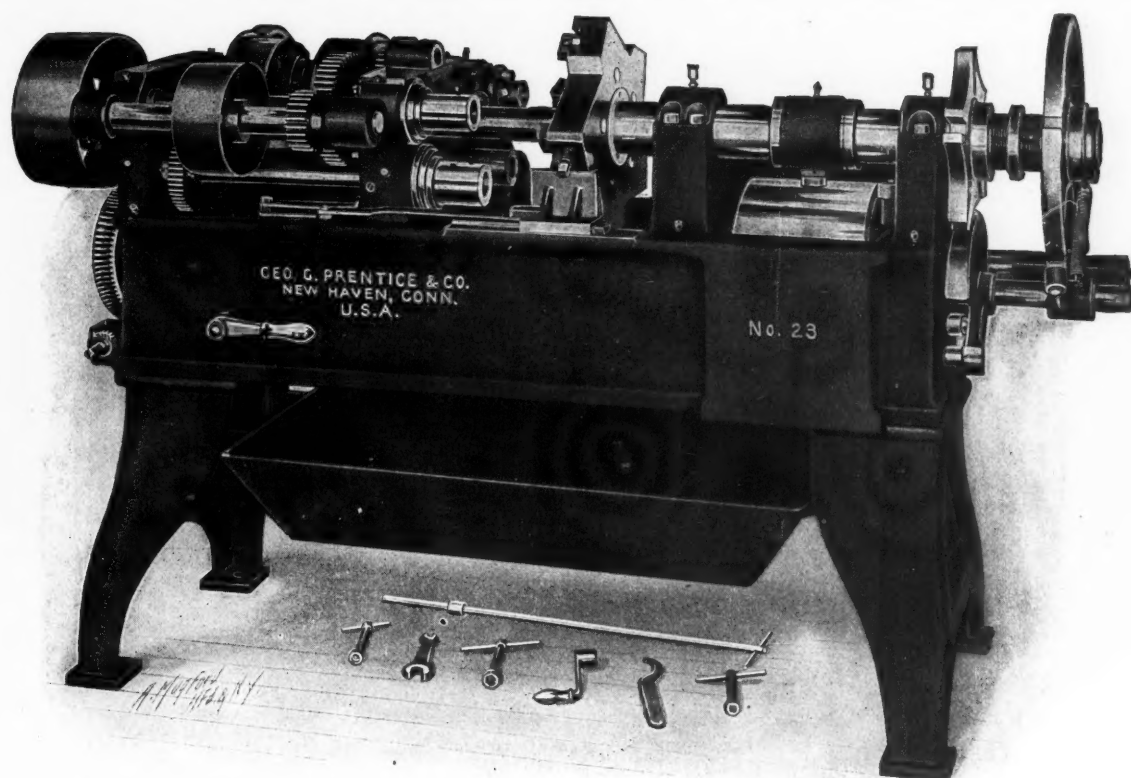
WESTINGHOUSE MFG. CO., Pittsburg, Pa., lately received an order from the City Electric Co., San Francisco, for a 15,000 horse-power Westinghouse-Parsons steam turbine. This will be the most powerful steam turbine west of the Mississippi River, its power capacity being equal to about ten of the largest railway express locomotives. A 5,000 horse-power steam turbine is being built on order for the city of Detroit and another of the same size for the Nichols Copper Co., Laurel Hill, Long Island.

H. MUELLER MFG. CO., Decatur, Ill., has increased its annual pay-roll $20,000 as a result of increasing wages five per cent. About seventy-five per cent of the 650 employes of the company participate in the increase, which dates back to February 4. Hereafter the date for conferring with employes on the wage question will be May 1, that date being a better time for judging the year's business than is the earlier date. The policy of the company has been to pay its employes according to the volume of the business and profits made. The pay-roll for 1908 was $371,250, and it is expected that for 1909 it will exceed $400,000.

WARNER & SWASEY CO. has just purchased the unoccupied half of Brown & Sharpe Mfg. Co.'s lot on Washington Boulevard, Chicago, Ill., and will at once erect a building for its Chicago offices with large showrooms for the display of its complete line of high-grade machine tools. The lot has a frontage of seventy-five feet, and the building to be erected thereon will be of the same height and general dimensions as the Brown & Sharpe Mfg. Co.'s building adjoining; it will be ready for occupancy in the Fall. The location is so near the new railroad station that many believe it will in the near future become the machine tool center of Chicago.

MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio, manufacturer of lathes and sensitive drills, and the Dayton Machine & Tool Works, manufacturer of grinding machines, have consolidated under the name Miami Valley Machine Tool Co. Mr. David Wilson, who has been sole owner of the Dayton Machine & Tool Works, and who has had long experience in the building of machine tools, will be actively connected with the new company and will give his attention to the building of the Dayton grinders as well as the Miami Valley lathes and sensitive drills. The consolidation simply means the enlargement of two growing concerns, and the business of each will be conducted under more favorable conditions.

REEVES PULLEY CO., Columbus, Ind., has published a booklet entitled "Engineering Manual," which contains the practical and tech-
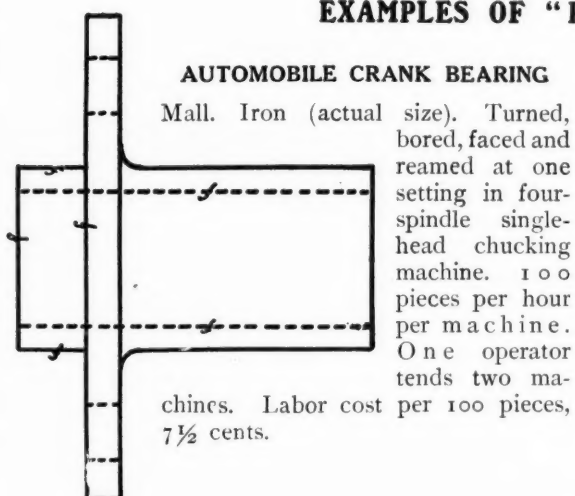
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nical details necessary for estimating for the installation of the Reeves variable speed transmission. While the manual was compiled for the use of salesmen, installation engineers, and superintendents, it will be found of equal value to the prospective customer and manufacturer who wish to obtain complete information on the construction and application of this form of transmission. The manual, bound in leather, will be sent, post-paid, on receipt of $1. It will be sent free, bound in heavy paper, to reputable engineers and manufacturers.

GEORGE V. CRESSON CO., Philadelphia, Pa., held commencement exercises Thursday evening, April 29, for its apprentices, graduated under the supervision of Mr. J. W. Bourn. The company has a foremen's association which meets the last Thursday night in each month and the two meetings were combined, twenty-two foremen and heads of departments being present. The company has thirty-five apprentices, and the graduates were handed their diplomas by Mr. F. N. Cresson, managing director, who presided. Brief remarks were made by H. R. Stacks, superintendent; Mr. Stuts, instructor; Mr. Johnson, assistant superintendent; Mr. Andrew, instructor of the manual training school; Mr. Beason, one of the oldest employes and a foreman. Sixteen apprentices received diplomas for finishing their courses in mathematics or drawing, and six of the boys received diplomas for both. These were regarded as honor men. The work of the winter is considered very satisfactory; many of the boys developed remarkably under the training of Mr. Bourn and his assistants.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ASIATIC AGENCY wanted for American Machinery by Japanese technical graduate, age 35. T. I., 312 South Carolina Ave., S. E., Washington, D. C.

BLUE PRINTS, TRACINGS, PLANS.—Large or small quantities, cheaper than you can make them yourself. Box 371, Hull, Quebec, Canada.

DRAFTSMEN cannot know too much about shop practice—many of them know too little and are handicapped thereby. MACHINERY'S Shop Operation Sheets can help greatly. They are direct, definite and practical. The set now comprises 102 distinct operations. Write for "Self-Education." MACHINERY, 49-55 Lafayette St., New York City.

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DRAWINGS, TRACINGS, ETC., MADE.—Prices reasonable. Box 1302, Orange, Mass.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work promises to be the most widely useful book published in years. Price 25 cents. See announcement on pages 131-134 this number of MACHINERY. Address MACHINERY, 49-55 Lafayette St., New York City.

FOR SALE.—UP-TO-DATE MACHINE SHOP in New Jersey, employing 14 hands. Exceptional opportunity. Investigation solicited. Good reasons for selling. Address R. M., Box 1216, New York City.

Have you any intricate mechanical problems to solve? If you have, let me solve them for you at a saving of money, time and trouble. Developing inventions to a practical and commercial basis my specialty. BENJAMIN BROWNSTEIN, Mechanical Engineer and Expert Designer, Gundling Bldg., Trenton, N. J.

MACHINERY'S DATA SHEETS will cost $4.00 a set, eight weeks from June 1. The price is $2.50 now. See special offers on pages 131-134, this issue. Address MACHINERY, 49 Lafayette St., New York City.

MAKE DRAWINGS, TRACINGS, BLUE PRINTS, Designers and Draughtsmen. Prices reasonable. THE SPREEN ENGINEERING COMPANY, JACKSON, MICH.

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PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an investigation and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

SITUATION WANTED as Superintendent or General Foreman. Valve concern preferred. Capable of turning out work cheaply and quickly. A 1 mechanical knowledge and ability. General and practical education. Desire moderate salary and can furnish best of references. Address Box 213, care MACHINERY, 49 Lafayette St., New York City.

SMALL SPECIALTIES to manufacture, by well equipped shop. Address B. L. H., care MACHINERY, 49 Lafayette St., New York.

TEST INDICATORS.—H. A. LOWE, 1374 E. 88th St., Cleveland, Ohio.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry, is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in MACHINERY'S Reference Series fully described in a pamphlet sent free on request. MACHINERY, 49-55 Lafayette St., New York City.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; 1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbia, Pa.

WANTED.—Copies of RAILWAY MACHINERY for October. 1908. State terms. V., care MACHINERY, 49 Lafayette St., New York.

WANTED.—Copy of MACHINERY, Engineering or Foreign Edition, for October, 1907. Address, with price, Foreign Dep't., MACHINERY, 49 Lafayette St., New York City.

WANTED.—GENERAL FOREMAN OR ASSISTANT SUPERINTENDENT by old established concern making high-grade stationary gasoline engines. Must be experienced on this class of work but also must be man who thoroughly understands rapid production; who is young and full of energy and a thorough executive. Only a man who thoroughly understands his business is desired. Location in city of 30,000 people. Concern is now producing 25 engines per day. State fully experience, whether married or single, also salary expected. Address Box 212, care MACHINERY, 49 Lafayette St., New York City.

WANTED.—POSITION AS SUPERINTENDENT, Factory or Works Manager, or as General Foreman. Age 39. North Atlantic States preferred, but would consider good position elsewhere. Twenty years' experience, have made special study increasing output and decreasing cost of production. Possess executive ability to handle large number of men. Address H. E. W., Box 99, care MACHINERY, 49 Lafayette St., New York City.

WANTED TO PURCHASE: HYDRAULIC OIL SEED CRUSHING PRESSES AND PUMPS. Must be in good working order. Write, stating particulars and lowest price. W. G. DEAN & SON, INC., MUSTARD MFRS., 246 PLYMOUTH ST., BROOKLYN, N. Y.

WANTED.—Two or three new or second-hand speed lathe heads, on four-foot beds, with legs; no other parts required; 12-inch cones for 2½-inch belt; 12-inch by 3-inch. T. & L. on C. shaft. Address, with price, Box 215, care MACHINERY, 49 Lafayette St., New York City.

WE CAN DESIGN YOUR COMPLICATED TOOLS. Drawings, tracings, blue prints. We also make tools, dies, jigs, models, etc. Experimental work. Inventions perfected. Send sample or blue print for estimate. Designers, draftsmen and toolmakers. BEACON TOOL WORKS, 146 Ward St., Naugatuck, Conn.

WE MAKE A SPECIALTY OF CONTRACTING to build lines of medium grade and weight machinery, and being in position to take on one more contract, will build, store and ship direct to consumer, any machines you wish manufactured. The very highest references from New York companies, for whom we now manufacture, as to our ability to give the most prompt service, combined with exceptional shipping facilities. HOYSRADT & CASE, KINGSTON, N. Y. Makers of Precision Disk Grinders, Positive Pressure Blowers and Special Machinery.

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